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Excavating Methods and Equipment on the Cape Cod Canal*

By E. F. Verplanck†

SYNOPSIS—The history and general features of the Cape Cod Canal were given in Engineering News, *of Jan. 9, 1913, but little was given at that time descriptive of the steamshovel and dredging plant, which includes two of the most powerful dipper dredges on the coast. The following article describes the excavating machinery and method of excavation in detail.*

During the past year little work has been done upon the approach channels of the Cape Cod Canal. In Cape Cod Bay, where the deep water exists half a mile from shore, the entrance is nearly finished. The six-mile channel down the head of Buzzards Bay, which is more than four-fifths completed, has been occupied during the past year by only two dredges, each for a month. Practically all the activity since Nov. 1, 1912, has been confined to the advancement of tide-water across the peninsula.

To expedite this, every effort has been made to facilitate the removal of as much material as possible from the inland portions of the canal. A 15-in. suction dredge was dismantled at the head of Buzzards Bay and reassembled in a new hull in a swamp two miles inland. This machine pumped ashore material from the canal prism for nearly a year before the dipper-dredge working in from Buzzards Bay reached it. During this interval, the pump made scow floatage for nearly a mile (from Sta. 316 to Sta. 277) through the marsh-land of the shallow, tidal Monument River.*

There has been a continuous steamshovel excavation for the past three years by an average plant of three 70-ton machines. These had, at the beginning of the present year, removed all material inside the canal to an elevation 8 ft. above mean sea level, which was the limiting depth for dry excavation. This same method has in the past year been made available for deeper excavation by the installation of alternating-current electric-pumping machinery and the maintenance of two earth-fill dams, whose crests are well above high water.

Fig. 1. The Cape Cod Canal from the Watershed Divide at Bournedale to the Eastern Entrance in Cape Cod Bay

Three 70-ton steamshovels during the spring and summer of 1913, completed to low water, the excavation in a stretch a half mile in length (between Sta. 210 and 233) 3000 ft. in front of the Cape Cod Bay heading. These dredges are now carrying the excavation down to 15 ft. below mean sea level in the one-mile reach between this partially completed section and the heading of the suction dredge cut (at Sta. 277) in the Monument River on the Buzzards Bay side, to which reference has been made above.

*Photographs by F. C. Small, Buzzards Bay, Mass. Dredge data revised by E. L. Voy, Mechanical Engineer of the Furst-Clark Construction Co., Sandwich, Mass.

†Engineer, Cape Cod Construction Co., Buzzards Bay, Mass.

*The name of this river appears to have undergone a curious metamorphosis. In the earliest documents it appears as an Indian name Manomet, also the early name of the present Buzzards Bay. In the official reports of the last century it was called Monumet, which is the name with which we designated it in our historical summary in "Engineering News" of Jan. 9, 1913. The newer atlases give it as Monument, which is evidently far from its original meaning, whatever that was.—Editor.

TEN-YARD DIPPER DREDGES—Two of the most powerful dredges on the Atlantic coast are at work in the tide-water headings. They were designed and constructed by the American Locomotive Co., to dig the Cape Cod Canal, and were assembled at the head of tide-water on opposite sides of the peninsula where they were launched, in the spring of 1912.

These machines were 10-cu.yd. dipper dredges of the Atlantic type. Their design is especially adapted to heading excavation, where lack of scow floatage in advance of the cut prevents carrying the sc[illegible]ead of the dredge. The crowding engine located [illegible] boom gives the positive control over dipper-hand[illegible]pula-tions necessary to move the bucket in or out [illegible] to suit any location of the scow pocket. The forwa[illegible]ds are placed 18 ft. back of the bow to permit the boom a full 90° swing on either side.

The structural steel hull is 135 ft. long, 42-ft. beam, 12 ft. deep at the bow and 10 ft. deep at the stern, and has about 4 ft. freeboard. Two longitudinal steel trusses

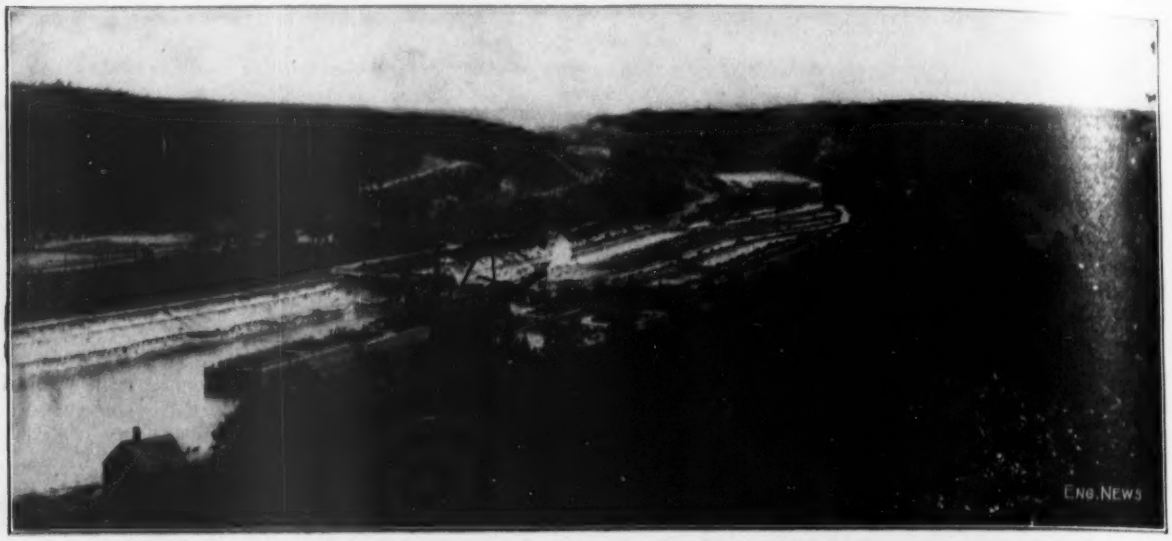


FIG. 2. THE CAPE COD CANAL FROM THE WATERSHED DIVIDE AT BOURNEDALE, LOOKING WESTWARD INTO THE MONUMENT RIVER VALLEY

FIG. 3. LOOKING EAST FROM THE DAM AT THE WEST END OF THE UNWATERED SECTION; WATER DELIVERED BY ELECTRIC PUMPS IN THE FOREGROUND AT ABOUT MEAN SEA LEVEL

extending for the full length of the hull, help to distribute the weight of machinery and boilers, and afford necessary rigidity against digging strains, excessive pinning-up and heavy seas.

The boom is of the box-girder straight taper type, of structural steel. It carries a 12x15-in. double-cylinder compound-geared crowding engine, and an independent double-cylinder rock-hoist engine. The dipper handle, of steel-plate construction reinforced by timber, is 70 ft. long and can dig in 40 ft. of water.

An 18x24-in. double-cylinder, link-motion, steam-reversing main engine operates the hoisting and backing drums. Compound gearing drives the grooved-steel double-cone hoisting drum, 54 in. in diameter at the sides and 71 in. at the center, by a steam-ram-actuated single-band friction. The backing drum, driven by a friction of similar type, is cylindrical and 48 in. in diameter. A 10x14-in. double-cylinder, balanced-valve, reversing engine swings the turntable, which is on the main deck and carries the boom, of which the turntable is a structural part.

The structural steel outboard forward spuds are 42 in. square, 60 ft. long, and are set back from the bow 18 ft., as above noted. The spuds are operated by 12x15-in. double-cylinder independent engines by means of 2¼-in. hoisting and pin-up cables. The stern spuds are 30 in. square, 65 ft. long, also of steel. Each is operated by a 8x8-in. double-cylinder engine by means of rack and pinions.

The 2½-in. double hoisting cables are carried from the hoisting drum over three 8-ft. diameter double-grooved sheaves to the equalizer on the bucket. The large diameter of these sheaves reduces wear from sharp flexure. The A-frame is 65 ft. high and made of channel- and latticed-steel construction.

Steam at 135 lb. pressure for continuous operation is furnished by two double-furnace Scotch marine boilers. There is in addition a 48-in.x8-ft. vertical auxiliary boiler carrying 125 lb. of steam. All engines except those located on the boom, are arranged to operate either condensing or noncondensing.

The buckets are round-nosed with manganese-steel lip. The equipment includes square-nosed buckets with removable manganese-steel teeth for rock work. One dipper cycle occupies 40 seconds.

The dredge equipments include two three-drum steam deck winches at the bow and two steam capstans at the stern for scow handling, surface condenser, large fresh-water tanks, 10-kw. electric-lighting plant, refrigerating plant, uptodate fire and sanitary arrangements, and sleeping accommodations for 40 men.

The design and construction of these machines was under the personal supervision of Thomas Jardine, Mechanical Engineer, Steamshovel and Dredge Department, American Locomotive Co., and A. D. Morris, Mechanical Engineer, Manager of Furst-Clark Construction Co., at Sandwich, Mass. They were built in the Rogers Locomotive shops of the American Locomotive Co., at Paterson, N. J., and reassembled and launched on Cape Cod.

FIG. 4. STEAM-SHOVEL EXCAVATION IN UNWATERED CENTRAL SECTION BETWEEN TEMPORARY DAMS; SHOVELS ARE 15 FT. BELOW MEAN SEA LEVEL

DREDGE PERFORMANCES—These dredges began excavating the Cape Cod Canal on Sept. 1, 1912. The dredge "Governor Herrick" was moved into the Cape Cod Bay heading (which was at that time at Sta. 130). The dredge "Governor Warfield" began at Sta. 400 to deepen the flotation channel which then existed for a mile up the Monument River. During the fall of 1912, small progress was made. The customary working-out of defective parts, to be expected in all new machinery, caused frequent stoppage. When the dredges were hauled off in January, 1913, their aggregate excavation since starting work failed to exceed 250,000 cu.yd., place measurement, or an average of about 32,000 cu.yd. per machine per

month. One was taken to Boston and the other to New York, where they were subjected to two months of the repairs, renewals and changes, of which the first four months of operation had indicated the necessity.

When the "Governor Warfield" and the "Governor Herrick" returned to the canal in March, 1913, they began working continuously, three 8-hr. shifts per day; each has since then averaged very nearly 100,000 cu.yd., place measurement, per month. In June and July, 1913, the "Governor Herrick" sent 120,000 cu.yd., and 131,000 cu.yd., respectively, to Cape Cod Bay. It is believed that this latter figure constitutes a record heretofore unduplicated by any dipper dredge in existence. It is even more remarkable, when consideration is taken of the conditions imposed upon a machine making her own scow floatage in a heading, where among other adverse circumstances scow during loading, because of the physical impossibility of pushing it far enough forward to load more than the three head pockets.

In August, 1913, the "Governor Herrick" encountered (near Sta. 180) most adverse digging. The substrata of the Cape Cod Canal 150,000 cu.yd., place measurement, in one month.

On Oct. 13, however, it was decided to set the machine to work cleaning up the Buzzards Bay channel off Wings Neck (between Sta. 590 and 630), where much rough weather prevented the excavation for the month from exceeding 90,000 cu.yd. The transfer was made in order to permit the steamshovels to work in the unwatered section between the headings until the "Governor Herrick" reached the east dam (at Sta. 210), which would require at least three months. The "Governor Warfield" would have reached the dam at the west end of the shovel sump in less than a month. A small 6½-cu. yd. dipper dredge was therefore placed in the west or Buzzards Bay heading and the "Governor Warfield" was left available for channel excavation.

Since Nov. 1, 1912, the distance across Cape Cod separating tide-water had been decreased 12,000 ft. Of this, over one mile was made on the Cape Cod Bay side. The Buzzards Bay heading has been advanced nearly 7000 ft. up the Monument River.

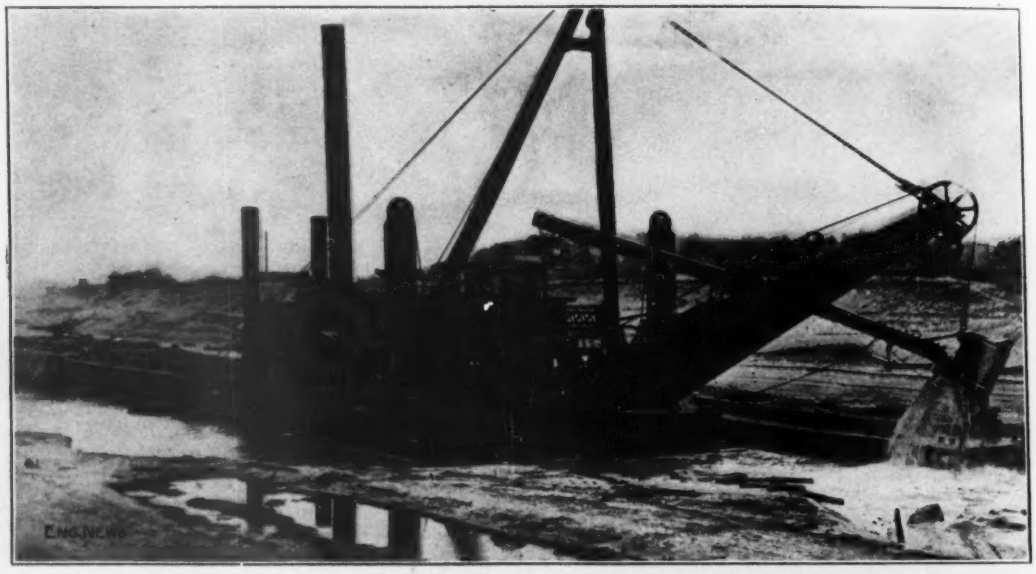


FIG. 5. THE 10-CU.YD. DIPPER DREDGE "GOVERNOR HERRICK" AT THE POINT OF GREATEST CENTER LINE CUT

were found to be impregnated with the boulders, with which the glacial drift of this region abounds. Some were of such magnitude as to necessitate the dredge kicking back to give opportunity for drilling and blasting. To these unfavorable conditions almost entirely can be attributed during August and September, 1913, the failure of the monthly excavation of the dredge "Governor Herrick" to exceed 90,000 cu.yd., place measurement, per month.

The season's performance by the "Governor Warfield" in the Buzzards Bay heading has been more uniform. Constantly contending with boulders and hardpan, the monthly output increased from 50,000 cu.yd. in April to 110,000 cu.yd. in July, and was maintained a rate of 120,000 cu.yd. throughout August and September, 1913, and during the first ten working days of October, this dredge dug 6000 cu.yd. per day. Had this been continued during the remainder of the month, there would have been towed to sea from the Buzzards Bay heading

To make the rate of advance as great as possible, the heading cuts were made of the smallest size in which scows and tugs could be conveniently handled. The headings consisted of two 40-ft. cuts leaving 18 ft. of water. This opened a channel in which any number of smaller machines could be placed at work, finishing the excavation to the full depth of 25 ft. across the full bottom width of 100 ft. On the Cape Cod Bay side, two 5-cu. yd. dipper dredges were thus employed. To the cleaning-up plant of two 6-cu.yd. machines on the Buzzards Bay side, there was added the 15-in. suction dredge when the "Governor Warfield" entered its cut in July. A 5-cu.yd. machine working on the beginning of the approach channel in the mouth of the Monument River completed the Buzzards Bay plant.

The 4,000,000 cu.yd. which were removed from Cape Cod between Nov. 1, 1912, and Dec. 1, 1913, leave less than 3,000,000 cu.yd. of the total of 17,000,000 to be excavated. This has produced more superficial changes

than the work of former years, which had consisted largely in dredging the approach channels.

A year ago, the canal was nearly completed for the first three miles in from Cape Cod Bay across the marshes. From here to Bournedale, a distance of one mile, the canal crosses the dividing ridge between low sand hills through a flat valley 1000 ft. broad and about 30 ft. above the level of the sea. In this section, steam-shovels were removing the last of the dry excavation at that time.

From Bournedale to Buzzards Bay the canal follows the valley of the Monument River, which is not greatly above sea level. Extensive shovel excavation had been carried on at one place (between Sta. 220 and 267) where the canal cut into the sand hills rising to the northwest. At the lower end of the river only 6000 ft. of small flotation channel had been dredged. There were, a year ago, several places in this stretch between Bournedale and the head of Buzzards Bay where there had been absolutely no excavation. The Buzzards Bay approach channel was 82% completed. Today Bournedale could become a seaport. Cape Cod Bay tide-water extends across the watershed, and the dredge "Governor Herrick" is excavating in the bed of the upper Monument River.

A distance of 12,000 ft. separates this from deep water in the Monument River, which now exists for two miles up from its mouth and between the two headings steam-shovels are digging to 15 ft. below sea level. When the dipper dredges enter this interior section, which will be flooded early in the spring of this year, 10 to 15 ft. of water will extend across the peninsula. The completion of the cleaning-up excavation and the riprapping of the slopes, which is at present 50% completed, will occupy less than a year. Late in 1914, the new canal will be available to the enormous traffic of 25,000,000 tons that annually rounds Cape Cod.

The construction work is being done through the Cape Cod Construction Co., of which William Barclay Parsons, of New York, is Chief Engineer, Eugene Klapp, of New York, Deputy Chief Engineer and Charles T. Waring is Resident Engineer, at Sandwich, Mass. The dredging is being done by the Furst-Clark Construction Co., of Baltimore, Md., and Galveston, Tex., of which H. S. Andrew is the General Manager at Sandwich, Mass. The steamshovel work is being done by the E. W. Foley Construction Co., of New York City. The Degnon Construction Co., of New York City, who have nearly completed the 3000-ft. breakwater on the Sandwich beach at the eastern entrance to the canal, are undertaking the riprap work.

Methods of Paying for Water-Works Mains

San Francisco, Calif., being, as it hopes, on the eve of municipal ownership of water-works, its supervisors (city council) secured from Percy V. Long, city attorney, an opinion as to ways legally open for meeting the cost of water mains. Mr. Long's report, with the omission of a few statements of fact or opinion familiar to most of our readers, is as follows:

A procedure adopted by some municipalities owning water-works for the laying of water mains is to charge the whole or a part of the cost thereof upon private property according to frontage, or upon districts according to benefits. Laying of mains is put in the same category as laying of sewers, paving of streets and the ordinary street improvements, the cost of which is chargeable against the property benefited.

Subdivision 10 of Section 2 of the Los Angeles charter provides that the city of Los Angeles shall have the right and power to levy assessments on property, according to frontage, or on a district, according to benefits, for laying water mains.

The objection to this plan is that the city conducting a water-works, engages therein for purpose of profit, and the business should carry the burden of its cost. The answer made to the objection is that the city does not, in conducting a water-works, engage therein for purpose of profit, but solely to furnish a necessary service at the smallest expense to the consumer, and that profit is only justifiable to pay the cost of extension to the main system and to cover future deterioration and replacement in the system and things of a kindred nature.

If the plan should be carried out it will have the effect of materially lowering water rates, making the cost of water its actual cost of production.

Another plan that has been followed is that whenever property owners desire the extension of mains the property owners shall pay the cost of such extensions into the city treasury, and when upon a proper survey it is shown that a permanent annual income of a given per cent. is being derived from such mains, the money shall be returned to the property owners paying the cost of the mains.

A third plan is the assessment plan to which is coupled the plan of paying back to the assessed property owners money advanced by them for the cost of the extensions whenever the returns from the extensions shall warrant such return. This plan is different in theory from the straight assessment plan, since ultimately the cost is to be paid out of the profits of the business. It saves loss of interest on capital invested, and obtains the capital invested from the returns of the business.

The value of this plan is that it provides a method for paying the cost for the laying of mains without the issuance of bonds and saves the interest on the investment. This plan likewise results in a lowering of water rates, but not so materially as in the straight assessment plan.

A fourth plan is for the city itself to lay the mains and entirely assume the cost thereof through issuance of bonds. The objection urged to this plan is that either the sinking fund and interest must be obtained from rates collected on the whole system, or must be paid through yearly taxation on property in general. If the entire system, including water mains, is to be paid out of future revenues it is urged that water rates during the early years of the municipal ownership of the system must necessarily be high and a burden on the rate payers.

The charter, as it is now framed, permits only of the fourth plan. The only method laid down by the charter to construct a public utility is to pay the cost thereof out of current revenues or by the sale of bonds. The charter, however, may be amended so as to permit mains to be laid under the first, second or third plan outlined, or any other plan that may be devised. The plan to be adopted, if a plan other than the one permitted by the charter is to be followed, is a matter of policy to be determined by your Board and submitted to the people in the shape of a charter amendment.

Deep Caissons and High Pressures were employed in the construction of the piers for the Boulak Bridge over the Nile at Cairo, completed in 1912. For one pier the bottom of the caisson was 111½ ft. below the water surface, while for five piers the depth was 108 ft., and the air pressure carried reached as high as 50 lb. The working shifts for the different pressures ranged as follows:

Up to 28 lb., two gangs working 8-hr. shifts alternately.
28 to 40 lb., three gangs working 8-hr. shifts.
40 to 45½ lb., three gangs, each 6-hr. on and 12-hr. off.
45½ to 50 lb., six gangs working 4-hr. shifts.
50 lb. (during concreting of working chamber), four gangs working 3-hr. shifts, day only.

The time the men were required to stay in the air-lock for "decompression" on leaving the lock, varied as follows: Up to 35-lb. pressure, 1 min. for each 1.4 lb. of pressure; 35½ lb. to 42½ lb., 35 min.; 42½ to 45½ lb., 40 min., 45½ lb. to 50 lb., 45 min. Considering the long shifts and high pressures, cases of illness resulting from these conditions were not very numerous. Out of 492 men employed 100 were reported ill, the number of cases being 115. Of these, four proved fatal. The men were natives, and no difficulty was experienced in getting them to work in compressed air at ordinary rates of pay. The temperature in the working chamber was about 95° F.

The bridge was built by a French firm under the direction of Arthur T. Knowles, representing the Egyptian government.—"The Engineer," of London, England, Oct. 17, 1913.

Retracing Some of George Washington's Surveys: Washington as a Surveyor and Engineer

Surveyors employed by the United States Forest Service have recently had occasion, in the purchase of Federal forest lands, to check some property lines reputed to have been surveyed by George Washington 162 years ago. Of course, every schoolboy knows that the Father of his Country did some surveying during his youth, but the impression is generally given by his biographers that surveying was then a kind of aristocratic recreation. Indeed, one of the editors of Washington's works makes this semi-apology for his illustrious author: "Land surveying was then a profitable and genteel pursuit in the colonies, and it comported well with Washington's tastes and inclinations."

As a matter of fact, Washington took up surveying for the very same reason that young men take it up today—to earn an honest living. He was at that time the young brother of a landed gentleman and had no private fortune, or very certain prospects of one, and he needed the money. Of this we have positive proof in his own words, for in describing in a letter to a friend the hardships of a frontier surveyor's life he wrote: "Nothing would make it pass off tolerably but the good reward of a doubloon every day that the weather will permit my going out and sometimes six pistoles." A doubloon was equivalent in Washington's day to about $7.20 and six pistoles to $21.60; so the conclusion must be drawn that land surveying in 1750 was at least as profitable as at the present time.

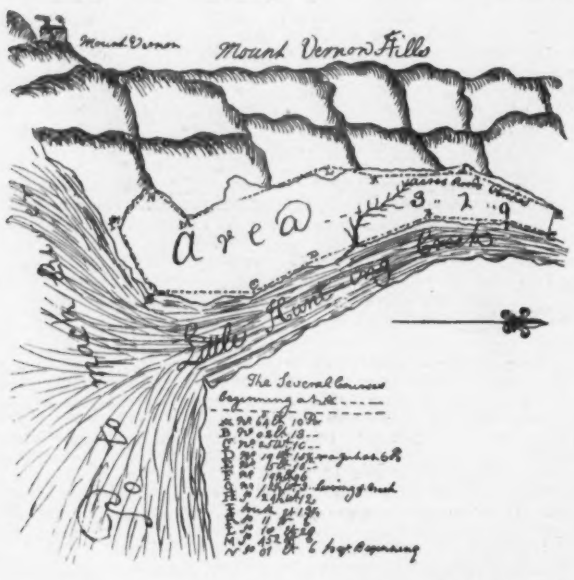


FIG. 1. FACSIMILE OF MAP OF ONE OF WASHINGTON'S EARLIEST SURVEYS; PART OF THE MT. VERNON ESTATE ON THE POTOMAC RIVER

Washington began to practice surveying when about 16 years old, and his first employer was his brother Lawrence Washington, the proprietor of the Mt. Vernon estate. He was soon after almost continuously employed for several years by his friend and patron, Lord Thomas Fairfax, the proprietor of an immense tract of land in what are now the western counties of the State of Virginia. Washington appears for a time to have run out his own lines as compass-man, but eventually he became rather more of a superintendent of land surveys for Lord Fairfax, and merely directed the work of two or more field parties.

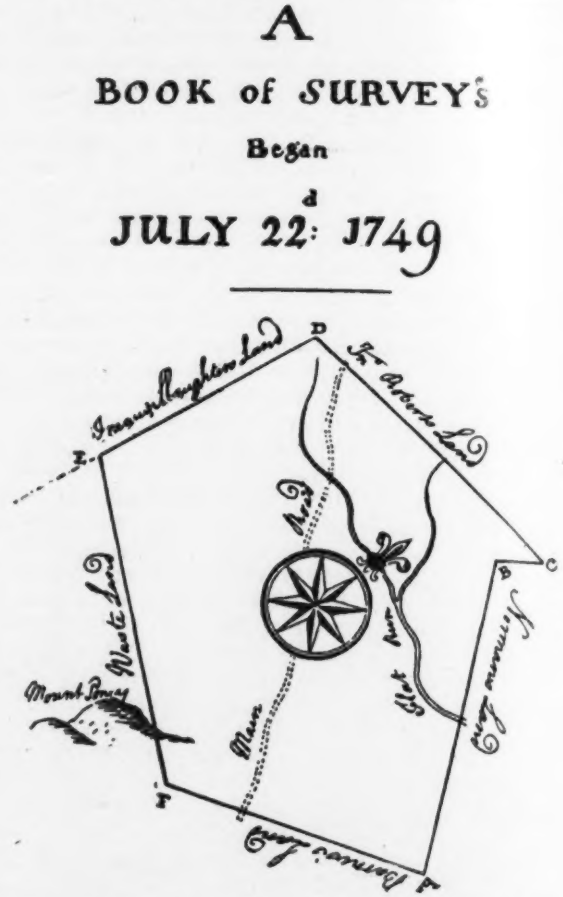


FIG. 2. FACSIMILE OF TITLE-PAGE OF SURVEY NOTE-BOOK IN WASHINGTON'S HANDWRITING

According to tradition, about 1751, when Washington was 19 years old, he surveyed for Lord Fairfax the line between what was to be Augusta and Frederick Counties, Virginia. These two counties were separated from what was then Orange County; and the grant to Lord Fairfax was to extend westward to the Pacific Ocean—one of the many examples of the generosity with which this continent was parceled out to the early settlers and friends of royalty. Subsequently these large tracts were further subdivided, so that the "Fairfax line" as it is generally known, runs now between Rockingham and Shenandoah Counties, with the original Augusta and Frederick Counties on the south and north, respectively.

The line was surveyed as a straight course from the head spring of the Hedgman River, one of the sources of the Rappahannock, to the head spring of the Potomac River. The approximate course was first determined by building bonfires on intervening high points, after which the line between was run by compass. Of course, the simple old-style compass without a telescope was used

and even George Washington's line could not be expected to check absolutely with the line run last summer by the Forest Service surveyors using modern instruments. Nevertheless, these same surveyors are authority for the statement that the line had been run so carefully that but little variation was found in it. Even without instruments, it was possible to trace the course of the line with surprising distinctness, by means of boundary fences dating back to the early days, and by alternate blocks of standing timber and cleared areas bordering the line like the squares in a checkerboard.

Survey blazes cut in trees, and since grown over, have been cut away by surveyors in making resurveys, and a count of the annual rings of growth over the old scar have shown that they were made at the time Washington was surveying these lands and were presumably made under his direction. These blazes were so high on the trees that it is generally believed they were cut by Washington from his saddle on horseback, using a long-handled ax. The journal and scraps of notes of his survey work which have come down to us show that saddle horses were much used in his fieldwork.

Washington's earliest literary production was his "Journal of My Journey over the Mountains," which is a record of a surveying expedition for Lord Fairfax begun in the spring of 1748. This early literary effort is little known; it is quaint, and to surveyors and engineers of today an interesting curiosity. It contains a brief record of his adventures, and survey notes of numerous plots of land portioned out of the Fairfax estate to various pioneer settlers. Besides these are drafts of letters and a "love poem" or two. No extraordinary adventures were encountered, but many a surveyor of the 20th century has had similar experiences enough to appreciate some of these notes.

One of these is described in the "Journal" as follows:

Tuesday 15th We set out early with Intent to Run round ye 3d Land but being taken in a Rain & it Increasing very fast obliged us to return, it clearing about one oClock & our time being too Precious to Loose we a second time ventured out & Worked hard till Night & then return'd to Penningtons we got our Suppers & was Lighted into a Room & I not being so good a Woodsman as ye rest of my Company striped myself very orderly & went in to ye Bed as they called it when to my Surprize I found it to be nothing but a Little Straw—Matted together without Sheets or any thing else but only one thread Bear blanket with double its Weight of Vermin such as Lice Fleas &c

I was glad to get up (as soon as y Light was carried from us) I put on my Cloths & Lays as my Companions. Had we not been very tired I am sure we should not have slep'd much that night I made a Promise not to Sleep so from that time forward chusing rather to sleep in y. open Air before a fire as will appear hereafter.

The following day we set out early & finish'd about one oClock & then Travell'd up to Frederick Town where our Baggage came to us we cleaned ourselves (to get Rid of y. Game we had catched y. Night before) & took a Review of y. Town & thence return'd to our Lodgings where we had a good Dinner prepar'd for us Wine & Rum Punch in Plenty & a good Feather Bed with clean Sheets which was a very agreeable regale.

On Apr. 4, 1748, Washington suffered from the inconvenience, often met with by surveyors in the rural districts, of having the attendance of a crowd of curious onlookers. As that was in a day before photography he probably was not pestered by solicitations to "take pictures." He seems, however, to have been annoyed much as surveyors nowadays are, for he wrote:

We did two Lots & was attended by a great Company of People Men Women & Children that attended us through ye Woods as we went showing there Antick tricks I really think they seem to be as Ignorant a Set of People as the Indians they would never speak English but when spoken to they speak all Dutch this day our Tent was blown down by ye Violentness of ye Wind.

His survey party consisted of two chainmen, a marker-man and the instrument-man. Samples of Washington's field notes are as follows:

April 5th 1750 Plat drawn

Then Surveyed for John Lonem a certain Tract of waste Land Situate Lying & being in Frederick County & on Cacapehon & bounded as followeth beg: at two white Oaks under a clift of Rocks Edward Kinnison's Corner & run thence N° 37° Et Two hundd & Forty Poles to two hickorys & white Oak on a Mountain Side thence S° 53 Et Two hundd & forty Poles thence S° 38° Wt 274 Po. to Intersect Kinnison N Wt Line thence N Wt 240 to the begng Cons .....390 Acres

John Lonem
Saml Brown } Chs men
Nicholas Robinson M

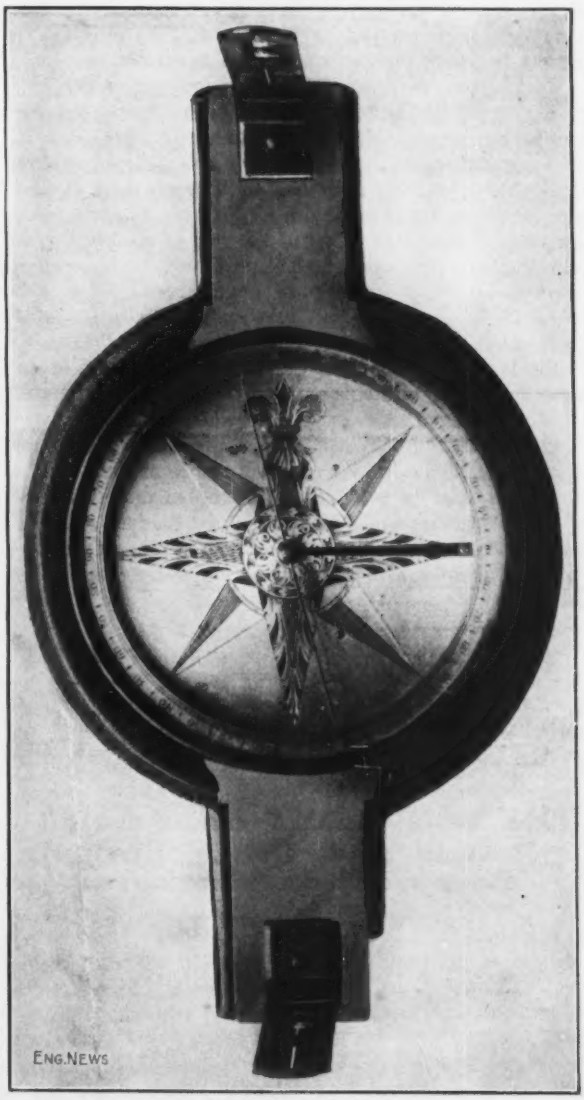


FIG. 3. COMPASS IN THE NATIONAL MUSEUM AT WASHINGTON, D. C., USED BY GEORGE WASHINGTON ABOUT 1750

(An American-made instrument graduated to ½°, with spring for lifting needle when not in use; manufactured by Rittenhouse, Philadelphia.)

In the latter part of the year 1753, Washington was delegated by the Governor and Council of Virginia to

undertake an important mission to the Westward, across the Allegheny Mountains, to the valley of the Ohio River. Besides his diplomatic errand to the Indian tribes he employed his time and talents to a large extent in taking notes and sketches of the topographical features of the country, and on his return to the seat of the colonial government at Williamsburg endeavored to impress upon the Governor and Council the importance of establishing a line of communication between the eastern and western settlements. At this time, it is presumed, he first conceived his project for a canal between the tide waters of Virginia and the headwaters of the Ohio, a project to which in later life he was much devoted.

Washington was, therefore, much more of a surveyor than is generally known, at a time when surveying was about the only branch of civil engineering practiced in America. Subsequently, Washington also made an exploratory survey of Dismal Swamp in Virginia, and at that time outlined a means of draining it which some years later was carried out. Most of the rest of his life was so full of public duties that he had no time for engineering, but that he always maintained an interest in it is evidenced by several facts. When Commander-in-Chief of the Continental Army he personally inspected the site of the proposed Cape Cod Canal, and recommended its construction for strategic purposes. The United States Lighthouse Service was established when Washington was President, and he is known to have given much personal attention to the building and maintenance of some of the first federal lighthouses. After his return to private life he was a member and chief engineering advisor of the James River and the Potomac companies, one of the objects of which was to construct a canal over the Allegheny Mountains. He selected the site of the present city of Washington.

So judged by the standards of civil engineering of the 18th century the man who was "first in war, first in peace and first in the hearts of his countrymen," might easily have been entitled to membership in an American society of civil engineers.

The Safe Loads on Derrick Booms and Other Long Compression Members

By Edward Godfrey*

Engineering literature holds little on the subject of slender compression members, particularly those subject to bending strains. The ordinary treatment of combined bending and direct compression, based either on the straight-line formula or the Gordon-Rankine formula, is of no value where slender members are concerned. The straight-line formula has no application to slender members, and the Gordon-Rankine formula is worse than useless where they are concerned, for it gives values (with the constant in general use) 100% or more, too great.

The Euler load is the absolute ultimate load that a slender column (or any other) can sustain. But the same slender member in bending and not in endwise compression can stand an extreme fiber stress several times as great as that produced by the Euler load. This is an anomaly, but it is quite in agreement with theory. Because this is true it can readily be seen that it is not proper to add the unit stress due to endwise load and the extreme stress due to bending, and to keep both these withwin a safe value indicated by the Euler load.

The proper method would seem to be this: First keep the direct compression well within a safe value indicated by the Euler load, say not as great as one-half of the ultimate (for this is an elastic limit and not a crushing limit); next find the total extreme fiber stress due to the endwise load and the bending, considering the effect of both initial deflection and increased deflection due to the endwise load, and keep this within safe limits for the material in bending.

To arrive at the combined unit stress spoken of in the last sentence of the foregoing paragraph, commonly used methods are not applicable. The column must be treated as a spring or bow, the end load of which increases the bow or deflection.

The writer will treat this subject in a manner similar to that by which he derived a straight-line formula for the design of ordinary compression members, as given in his book, *Steel Designing*. In Chapter X he demonstrates that there is a certain load which the theory of flexure shows would double the original bending of a column, whatever that bending may be. Because of that doubled versed sine there is a second added increment to the bending of the column; and because of this second increment to the bow bending, there is a third increment to the moment and to the bow. This will increase until failure in the column results, without added load. Though a column be perfectly straight (have a versed sine of infinitesimal amount), it will fail at this load, which is practically the Euler load.

If we take a slender member that is deflected from its own weight and calculate the deflection, it would give us the lever arm for finding the bending moment due to endwise load on the member while it is deflected this amount. But the application of this endwise load will increase the deflection or bow in the member, and consequently the bending moment due to the endwise load will be correspondingly increased. The problem is then to discover where equilibrium will be established; i.e., what is the limit of the deflection caused by the endwise load?

In Fig. 1, given a member of length L and weight W, subject to an endwise load P. Let d' be the deflection due to the weight of the member. Let M' be the bending moment due to the weight of the member; then

$$M' = \frac{WL}{8} \tag{1}$$

By the theory of flexure

$$d' = \frac{5\,WL^3}{384\,EI} \tag{2}$$

Let M'' be the bending moment due to the endwise load P in the member while it has the deflection d', then

$$M'' = \frac{5\,WPL^2}{384\,EI} \tag{3}$$

This is only a partial moment. It is an increment to the original moment M'; but because the deflection is increased, the resultant moment is greater than $M' + M''$.

*Monongahela Bank Building, Pittsburgh, Penn.

If, now, we assume that the elastic curve of the member is a parabola, which it closely approximates, the curve of bending moments from end to end of the member will be a parabola. Hence the endwise load would have the same curve of moments as the uniform load W; therefore, if the bending moment M'' were any given fraction of M' the deflection produced thereby would be the same fraction of d'.

Let d'' be the deflection due to M''. By reason of this deflection there is a third moment M''' and a third deflection d'''. These are the same fraction of M'' and d'' that the latter are of M' and d', etc. There is thus an infinite series the sum of which is the final moment in the member. The sum of the series

$$x + x^2 + x^3, \textit{ etc.} = \frac{x}{1 - x} \qquad (4)$$

When x is fractional this sum is finite, when x is unity the sum is infinite. Hence a load that would double the deflection due to the weight of the member (as a first increment) would cause ultimate failure. This is practically the Euler load. For this series

$$x = \frac{M''}{M'} \qquad (5)$$

Hence when M'' is less than M', the final bending moment, when equilibrium is established, may be calculated. Substituting this value of x in the expression for the sum of the series, we find

$$\textit{total added moment} = M' \times \frac{M''}{M' - M''} \qquad (6)$$

Hence the

$$\textit{final moment} = M'\left(1 + \frac{M''}{M' - M''}\right) = M'\left(\frac{M'}{M' - M''}\right) \qquad (7)$$

In making the application the bending moment is first found by equation (1). Then by equation (3), M'' is found. These values are substituted in (7).

As an example: given a 14x14-in. timber boom 70 ft. long, subject to an endwise load of 33,000 lb. The weight of the boom is about 4000 lb. and $M' = 420{,}000$ in.-lb.

Substituting in (7) the final moment is found to be 848,400 in.-lb.

The extreme fiber stress on the boom due to this bending is 1860 lb. The direct load is 170 lb., making the total extreme fiber stress 2030 lb. per sq.in.

This stress is obviously too great on a member whose *ultimate* strength as a column is 330 lb. per sq.in.; yet, this is a fair sample of practice in derrick booms. Derrick users will tell you that they have often lifted greater loads than this with unsupported booms of about these dimensions. In fact, this is a boom which was in regular use in this city eight years ago. In lifting a load that gave an endwise compression of 33,000 lb., the boom failed. It was inclined at the time so that its bending moment was not quite so large as that calculated above.

If this were a beam in bending only, and well stayed, a unit stress of 2000 lb. per sq.in. would be considered excessive. If it were a bridge member, and not slender, the compressive stress allowed would be less than half of this. The same engineers who rightly demand this standard in bridge design allow their work to be erected with equipment whose margin of safety is practically nothing. It is no wonder that so many "accidents" occur in erection work.

The attachment of the lines to the end of a boom may be such as to give bending moments on the boom, apart from the moment caused by the direct load and the deflection. These moments are of great importance in a slender member. If the boom line is not attached to the center of the end of the boom, there will be a bending moment that must be considered. The use of a split ring and shackles on the end of a boom is one way to make the load on the end of the boom very eccentric.

One method of overcoming the weakness of a slender boom is to support its weight by hitching the dead-end of the becket line to the boom about at its middle point or higher. If the pull on the line is just about enough to support the boom, all is well. But with varying loads the pull is apt to be too great, resulting in a deflection upward that may be just as large as a deflection downward and have the same element of danger.

In ENGINEERING NEWS, June 26, 1913, p. 1327, there was a description of a derrick whose boom broke while lifting only a little more than a ton. The boom is 10 in. wide (of two 10x10 pieces lapped and spliced) and 65 ft. long. The ultimate strength of this boom as a column is about 200 lb. per sq.in. The endwise load was about half of this. The boom was supported by the dead-end of the becket line at the middle point, and also by two parts of the same line on a sheave at about the upper quarter point. This was too great a pull for the weight of the boom, and there was a heavy bending upward. This on a boom that was already strained to its safe capacity as a slender column, was too much for the material, and the boom broke.

Slender members in such conditions as derricks, where the loads are so irregular and are apt to be excessive, should be avoided wherever possible.

The best way to avoid slender derrick booms is by the use of hog rods on the four sides of the timber. The posts for these hog rods should be well secured to the boom and the rods drawn up.

The Effect of the Addition of Hydrated Lime upon the change in volume of portland cement mortar and concrete test pieces under different conditions of exposure was investigated during the past year by Henry S. Spackman and reported by him to the Lime Manufacturers Association at its annual meeting Feb. 4, 1914. Mr. Spackman considered that it had been sufficiently proved that a reasonable percentage (say 10%) of hydrated lime added to cement mortar or concrete increased the plasticity and impermeability of that mortar or concrete without materially affecting the strength. The effect on change in volume, however, had not been hitherto demonstrated.

In the opinion of the author the test showed that variation in moisture content affects the volume of a mortar test piece more than change in temperature; but when kept from contact with water other than moisture in the air there is a marked tendency to shrinkage of the test piece, which tendency continues up to and beyond the six-month period. When the test piece is in constant or frequent contact with water the general tendency is toward expansion in volume, but with the draining off of the excess gaging water there is a marked shrinkage at the 24-hr. period followed in some cases by expansion in 48 hr., and further shrinkage if test pieces are out of contact with water and expansion if in contact with water. But the addition of hydrated lime while increasing somewhat the maximum expansion and contraction when the test specimens are constantly exposed either to water or the dry air markedly reduces the shrinkage due to the draining off of the surplus gaging water and also the extent of the movement when the test piece is alternately wet and dry.

The conclusion of the investigation was that the addition of hydrated lime will be found advantageous under ordinary climatic conditions in concrete work generally where it is exposed either to air or to fresh water, and concrete to which such additions have been made besides being more impermeable will show less change in volume under varying moisture content.

A Simplified Proof of the Three-Moment Formula for Continuous Beams

By S. E. Slocum*

The Theorem of Three Moments for continuous beams is ordinarily proved by such a complicated method of analysis that its physical basis is not apparent. The following simplified proof is based only on the deflection of a cantilever under various forms of loading, the rest of the demonstration being obvious on inspection. Al-

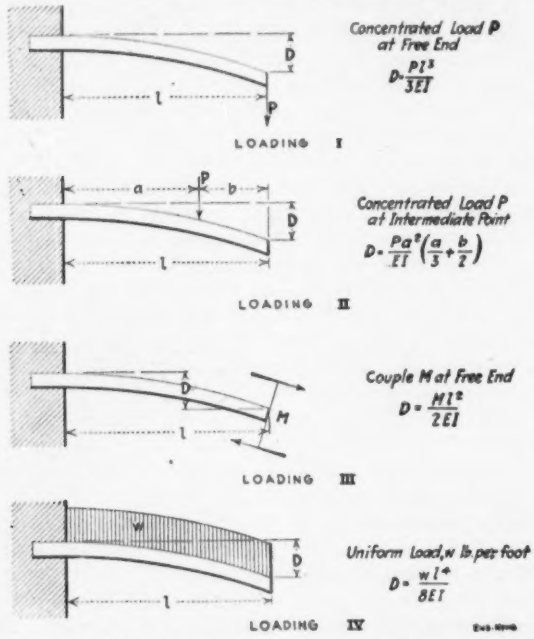


Fig. 1. Deflection of Cantilever Beams; Formulas for Four Cases

though the demonstration applies to the most general case, *including unequal settlement of the supports,* no calculus is used, and only a small amount of elementary algebra.

The well known formulas for the deflection of a cantilever under various systems of loading are summarized in Fig. 1 for reference. It may be noted that these deflections can all be obtained directly by simple geometrical processes without the use of calculus.

Continuous Beam Uniformly Loaded

Consider a continuous beam bearing a uniformly distributed load on each span, and let A, B, C, denote any three consecutive points of support, assumed to be at the same level (Fig. 2). Also let M_1, M_2, M_3, and R_1, R_2, R_3, denote the moments and reactions at these three points respectively; l_1, l_2, the lengths of the two spans considered; w_1, w_2, the loads per lineal foot on these spans; and S_1^l, S_1^r, S_2^l, S_2^r, etc., the shears, respectively, on the left and right of the supports A, B, etc

Cut the beam off just to the right of support A, but keep the right-hand part (Fig. 2a) in its previous position by applying moment M_1 and shear S_1^r at the cut end, equal to the forces (stresses) previously exerted on it by the left-hand part of the beam. The length AB is now obviously a cantilever, and the deflection of end A from the tangent at B (note that this tangent will not be horizontal, in general) can be computed by the formulas of Fig. 1. The shear S_1^r affects the beam like Loading I, the moment M_1 like Loading III and the load w_1 on the beam like Loading IV. The total deflection is equal to the sum of the deflections (D_1, D_2, D_3) which the three loads would produce if acting independently. By the formulas of Fig. 1,

$$D_1 = -\frac{S_1^r l_1^3}{3\,EI} \text{ (negative because upward)}$$

$$D_2 = \frac{M_1 l_1^2}{2\,EI}$$

$$D_3 = \frac{w_1 l_1^4}{8\,EI}$$

The total deflection of the point A, below the tangent to the beam at the point B is, therefore,

$$D_A = \frac{M_1 l_1^2}{2\,EI} - \frac{S_1^r l_1^3}{3\,EI} + \frac{w_1 l_1^4}{8\,EI}$$

To eliminate the shear S_1^r, form a moment equation for the segment AB when cut off as shown in Fig. 2b. Taking moments about B,

$$-M_2 = -M_1 + S_1^r l_1 - \frac{w_1 l_1^2}{2}$$

whence

$$S_1^r = \frac{1}{l_1}(M_1 - M_2) + \frac{w_1 l_1}{2}$$

and, substituting this value of S_1^r, the above expression for D_A reduces to

$$D_A = \frac{M_1 l_1^2}{6\,EI} + \frac{M_2 l_1^2}{3\,EI} - \frac{w_1 l_1^4}{24\,EI}$$

Exactly the same derivation applied to span BC will give an expression for the deflection of point C below the tangent at B. With the help of a sketch drawn like Fig. 2a, but for the other span (cut at C), the expression

$$D_C = \frac{M_3 l_2^2}{2\,EI} - \frac{S_3^l l_2^3}{3\,EI} + \frac{w_2 l_2^4}{8\,EI}$$

is obtained. Then, with a sketch similar to Fig. 2b, but drawn for span BC, a moment equation is written

$$-M_2 = -M_3 + S_3^l l_2 - \frac{w_2 l_2^2}{2}$$

which gives a value for S_3^l to be substituted in the previous expression. The final result is the equation for D_C,

$$D_C = \frac{M_3 l_2^2}{6\,EI} + \frac{M_2 l_2^2}{3\,EI} - \frac{w_2 l_2^4}{24\,EI}$$

As might have been foreseen, this result is exactly the same as the equation for D_A, with interchange of the

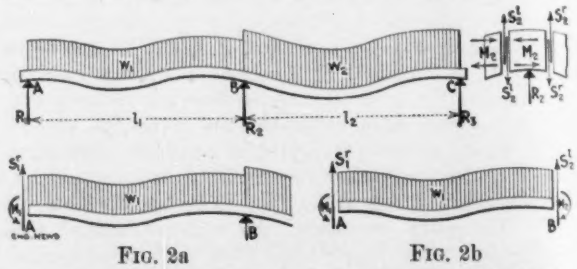


Fig. 2a Fig. 2b

Fig. 2. The Continuous Beam under Uniform Loading

*Professor of Applied Mathematics, University of Cincinnati, Cincinnati, Ohio.

values appropriate to support C and span l_2 for those belonging to support A and span l_1; i.e., the equation for D_C can be written direct from the D_A equation, without repeating the derivation.

The two deflections D_A and D_C are both measured from the same base-line, viz., the tangent to the beam at support B. They lie on opposite sides of this tangent, and form similar triangles with the tangent and the line ABC, as represented in Fig. 3. Therefore, they are proportional to the corresponding spans; but, as the

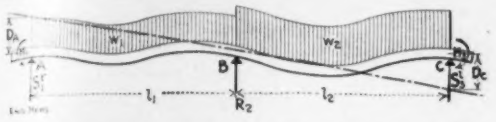


FIG. 3. PROPORTIONALITY OF DEFLECTION TO SPAN

positive values of deflection are measured downward from the tangent, and one of the two (D_C in Fig. 3) is upward from the tangent, a negative sign must be used to avoid equating a positive to a negative quantity, i.e.,

$$\frac{D_A}{l_1} = -\frac{D_C}{l_2}$$

Applying this relation to the previously found values of D_A and D_C, combining terms and eliminating EI, we obtain the relation

$$M_1 l_1 + 2 M_2 (l_1 + l_2) + M_3 l_2 = \tfrac{1}{4} (w_1 l_1^3 + w_2 l_2^3)$$

By referring back to Fig. 2a it will be seen that the moment M_1 was taken as positive, though of such direction as to bend the beam convex upward. The usually quoted formulas for beams apply the negative sign to moments of this direction. Therefore, to bring the above formula into harmony with prevailing practice, the signs of all the M terms must be reversed, or, what is the same thing, the negative sign prefixed to the right-hand side of the equation, giving

$$M_1 l_1 + 2 M_2 (l_1 + l_2) + M_3 l_2 = -\tfrac{1}{4} (w_1 l_1^3 + w_2 l_2^3)$$

The sign of the right member, however, does not affect the numerical values of the moments obtained by the use of this relation.

This is the *theorem of three moments for uniform loading.*

CONTINUOUS BEAM BEARING CONCENTRATED LOADS

Consider first a continuous beam bearing a single concentrated load in each span. If l denotes the length of any span, the distance from the concentrated load in this span to the adjacent support on the left will be denoted by kl, where k is a proper fraction and kl is therefore expressed in feet and is less than the full span (Fig. 4). Thus, if the load is at the middle of the span $k = \frac{1}{2}$; if it is at the quarter-point $k = \frac{1}{4}$, etc.

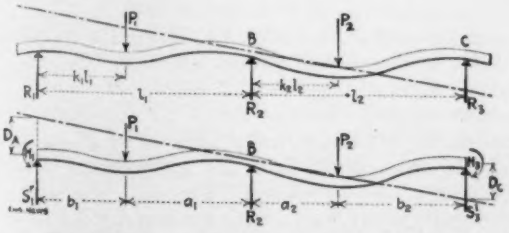


FIG. 4. THE CONTINUOUS BEAM UNDER CONCENTRATED LOADING

As before, consider a portion of the beam extending over three consecutive supports A, B, C. Use the same notation for reactions, shears and moments as before, and follow the same method of calculating the deflections of points A and C below the tangent at B.

Cut the beam by a plane just inside the support at A. Then treat the segment AB as a cantilever fixed at B, loaded at the free end A by the shear S_1^r and the moment M_1, and loaded at an intermediate point by the concentrated load P_1. The partial deflections, D_1, D_2, D_3, are taken from the cantilever table, Fig. 1:

$$D_1 = -\frac{S_1^r l_1^3}{3 EI}$$

$$D_2 = \frac{M_1 l_1^2}{2 EI}$$

$$D_3 = \frac{P c_1^2}{EI}\left(\frac{a_1}{3} + \frac{b_1}{2}\right) = \frac{P_1 a_1^2}{EI}\left(\frac{l_1}{2} - \frac{a_1}{6}\right)$$

The total deflection is:

$$D_A = D_1 + D_2 + D_3 = \frac{M_1 l_1^2}{2 EI} - \frac{S_1^r l_1^3}{3 EI} + \frac{P_1 a_1^2}{2 EI}\left(l_1 - \frac{a_1}{3}\right)$$

The value of the shear S_1^r is found, as before by cutting the segment off just to the left of B, applying at this cut end the stress forces S_2^l, M_2, and taking moments about B:

$$-M_2 = -M_1 + S_1^r l_1 - P_1 a_1$$

whence

$$S_1^r = \frac{1}{l_1}(M_1 - M_2) + P_1 \frac{a_1}{l_1}$$

Substituting this value in the expression for D_A,

$$D_A = \frac{l_1^2}{6 EI}(M_1 + 2 M_2) - \frac{P_1 a_1}{6 EI}(2 l_1^2 - 3 a_1 l_1 + a_1^2)$$

The deflection at C may be formed by the same method, or it may be written from the expression for D_A, by substituting the values appropriate to point C and span BC for those pertaining to point A and span AB. This may be done because in both cases the distance a is measured from the fixed end of the cantilever. Thus,

$$D_C = \frac{l_2^2}{6 EI}(M_3 + 2 M_2) - \frac{P_2 a_2}{6 EI}(2 l_2^2 - 3 a_2 l_2 + a_2^2)$$

The deflections D_A and D_C are proportional to the spans l_1 and l_2 (by similar triangles), but as one is negative (because it is an upward deflection) the proportion must contain a negative sign, i.e.,

$$\frac{D_A}{l_1} = -\frac{D_C}{l_2}$$

Inserting the above expressions for D_A and D_C and combining like terms, the result is,

$$M_1 l_1 + 2 M_2 (l_1 + l_2) + M_3 l_2 = P_1 \frac{a_1}{l_1}(2 l_1^2 - 3 a_1 l_1 + a_1^2) + P_2 \frac{a_2}{l_2}(2 l_2^2 - 3 a_2 l_2 + a_2^2)$$

Expressing a_1 and a_2 in terms of k_1 and k_2,

$$a_1 = (1 - k_1) l_1$$

$$a_2 = k_2 l_2$$

Substituting these expressions in the previous equation, and changing the sign of the right side for the reason explained under the heading of uniform load, the final equation is,

$$M_1 l_1 + 2 M_2 (l_1 + l_2) + M_3 l_2 = -P_1 l_1^3 (k_1 - k_1^3) - P_2 l_2^3 (2 k_2 - 3 k_2^2 + k_2^3)$$

Which is the *theorem of three moments for one concentrated load in each span.*

Special Case—For a single concentrated load at the center of each span, each k is ½ and consequently the theorem becomes in this case

$$M_1 l_1 + 2 M_2 (l_1 + l_2) + M_3 l_2 = -\tfrac{3}{8} (P_1 l_1 + P_2 l_2^2)$$

General Theorem—If there are several concentrated loads in each span, an equation like the above can be written for each load separately. By adding these equations we thus obtain the general expression for the theorem of three moments for any number of concentrated loads, namely,

$$M_1 l_1 + 2 M_2 (l_1 + l_2) + M_3 l_2 = -\Sigma P_1 l_1^3 (k_1 - k_1^3) - \Sigma P_2 l_2^3 (2 k_2 - 3 k_2^2 + k_2^3)$$

where each summation is to be extended over the loads in its own particular span.

Unequal Settlement of Supports

In deriving the theorem of three moments the supports have been assumed to be at a fixed elevation. If their relative elevation changes, due to unequal settlement or other causes, the effect will be to increase the stress in the beam or truss. To take account of this effect in formulating the theorem, assume that the supports were originally at the same level, and denote the settlement of three consecutive supports A, B, C, from their original level by h_1, h_2, h_3, respectively. Then the difference in elevation between A and B is $h_1 - h_2$, and between C and B is $h_3 - h_2$. Thus if A settles more than B, $h_1 - h_2$ is positive and the deflection at A is increased by this amount. If A settles less than B, $h_1 - h_2$ is negative and the deflection at A is decreased by this amount. In the general case, then, when the settlement of the supports is considered, the expressions for the deflections of A and C from the tangent at B become

$$D_A = -\frac{M_1 l_1^2}{6 EI} - \frac{M_2 l_1^2}{3 EI} + \Sigma \frac{P_1 l_1^3}{6 EI} (k_1 - k_1^3) + (h_1 - h_2)$$

$$D_C = -\frac{M_3 l_2^2}{6 EI} - \frac{M_2 l_2^2}{3 EI} + \Sigma \frac{P_2 l_2^3}{6 EI} (2 k_2 - 3 k_2^2 + k_2^3) + (h_3 - h_2)$$

Substituting these values of D_A and D_C in the proportion

$$\frac{D_A}{l_1} = -\frac{D_C}{l_2}$$

and combining terms, the result is

$$M_1 l_1 + 2 M_2 (l_1 + l_2) + M_3 l_2 = -\Sigma P_1 l_1^3 (k_1 - k_1^3) - \Sigma P_2 l_2^3 (2 k_2 - 3 k_2^2 + k_2^3) - 6 EI \left(\frac{h_1 - h_2}{l_1} + \frac{h_3 - h_2}{l_2} \right)$$

This expression is therefore *the most general form of the theorem of three moments*, including the effect of unequal settlement of the supports, or other change in their relative elevation.

New Water Intake at East St. Louis, Ill.

The flood-protection and drainage work of the East Side Levee and Sanitary District at East St. Louis, Ill., includes the establishment of a new shore line for the Mississippi River (considerably beyond the original line) and the construction of a river-front levee 31 miles long. This work has necessitated the reconstruction of the water-works intake and a sewer outlet.

Water-Works Intake

The City Water Co. formerly took its supply from the Mississippi River by means of two suction pipes, one 36-in. and one 30-in. diameter, which were conducted from the low-service pumping station to the vicinity of the inner harbor line through brick tunnels of 8-ft. and 6-ft. diameter, respectively. From this point they were supported by bents of piling to points further out toward the outer harbor line. The pipes were laid upon an incline so that only that part beyond the ends of the tunnels was submerged all the time. For this reason they were incased in tunnels further back so that they would be easily accessible at periods of low water, for making repairs such as stopping air leaks, etc. Each of these tunnels is about 600 ft. in length.

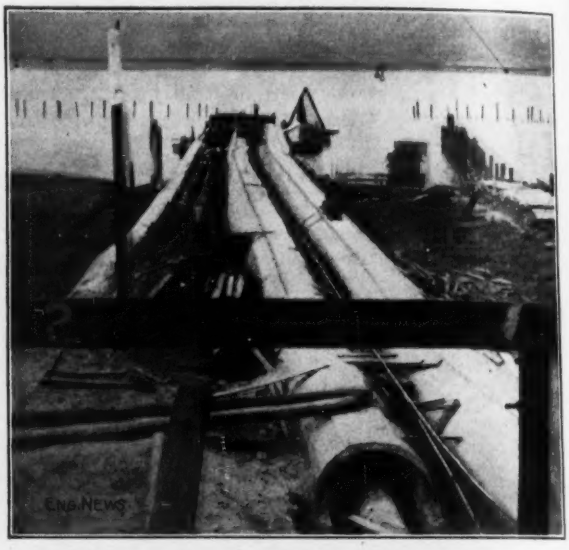


Fig. 1. Tunnels for the Water-Intake Pipes at East St. Louis, Ill.

(Four tunnels, each containing suction mains, extend to an intake chamber just beyond the scow lying at the right of the tunnels.)

The construction of the new levee, which will give a maximum fill of from 20 to 40 ft. over these tunnels, necessitated additional intakes to provide for the future. With this in view, two additional reinforced-concrete tunnels, one 8-ft. and one 6-ft. diameter, are being constructed parallel to the first two. The four tunnels are shown in Fig. 1, the two new ones being at the right. The board marked "2" is at the approximate elevation of the top of the new levee. The river was very low when this view was taken, being between the 3-ft. and 4-ft. stage.

The four tunnels terminate in an intake chamber 28x35 ft., and are supported over the soft sandy bottom

on piles spaced from 2½ to 3 ft. apart. The suction pipes coming from the pump house through the tunnels pass into the intake chamber and down to the bottom, where they are fitted with foot valves. This chamber is partitioned, and is equipped with sluice gates and with a centrifugal pump for use in cases of emergency.

From the intake-chamber lines of pipes will be extended into the river to the line of the toe of the levee at

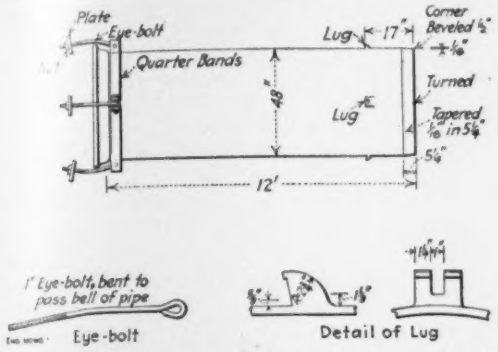


FIG. 2. SPECIAL PIPE WITH TAPERED END, LEAD RING AND CLAMP JOINT, FOR THE SUBMERGED INTAKE PIPES AT EAST ST. LOUIS, ILL.

the outer harbor line, a distance of about 240 ft. These will be suspended from a pile structure by U-bolts and stirrups, and the outer end of each will be fitted with a screen of iron bars fastened with brass stud-bolts. The pipes will be at different levels; two 48-in. and two 42-in. pipes at about 5 ft. below low-water stage in the river, and one 48-in. pipe at a higher elevation.

The placing of the submerged pipes is done by divers, but no calking is required under water, the spigot end of each pipe being fitted to a lead ring in the bell of the adjacent pipe, and the joint being secured by clamps which are placed by the divers. The pipe is cast specially for the work, and has four lugs near the spigot end, while this end is beveled in a lathe, as shown in Fig. 2.

In pouring the lead ring on the 48-in. intake pipes, the spigot is first entered into the bell, and the joint covered with an asbestos roll and clay, leaving an 18-in. gate at the top for pouring the lead. It was found that the gases frequently blew off the covering or roll before the job was done, thus spoiling the joint. To prevent this, the roll was held in place with a rope around the pipe, as shown, thus reducing the trouble from blowouts. Later on, the rope was replaced with a sectional band made of strap iron, but bent edgeways. After the lead has set, the pipes are separated. When the pipes are submerged, the diver has only to clamp them together, forcing the beveled end of the one pipe home inside the beveled lead ring already cast in the bell of the adjacent pipe.

In leading the joints, the spigot ends were not placed entirely home in the bells, and very little yarn was used. In order to keep the lead from leaking through the narrow strands of yarn, a great deal of fireclay was used on the inside, and the lead was poured from the top by means of a very large deep gate which permitted fast pouring, so that the lead would flow into the bell from both sides.

With pipe of such size (42- and 48-in.) and especially on a job of this kind, where the joints will be pulled apart and inspected, it was found to be a difficult proposition to pour the lead joints. Unless a very large kettle is used, there will be almost invariably breaks in the lead, caused by the flow stopping on one side or the other; or it will be found honeycombed, due to pouring too slowly and thereby cooling the lead. It is also important to use plenty of fireclay on the asbestos roll, and to block the roll on with a rope or a vertical band of some kind, or it will be blown off by the accumulation of gas in the lead ring of the bell, which cannot escape rapidly enough on account of the fast pouring.

The idea of not placing the pipe entirely home in the bell when pouring the lead is that when the joint is put together under water, the pipes can be drawn up tight, forcing the tapered end of the spigot pipe further into the lead ring and making a tight joint without calking.

This method might not be approved on suction pipe that would at any time be out of the water, but in this case the pipe is being laid considerably below the lowest stages of the river, so that air leaks will not be possible. Moreover, these suction lines are merely gravity pipes, which will convey the water from the river channel through the levee that is being constructed over them, to the intake chamber, from which the low-service pumps take the water.

After the pipe has been leaded and pulled apart, it is taken out on the barges to the end of the line already completed, and is lowered from a four-leg derrick, supported upon the bents of piling from which the pipe is to be suspended in large U-shaped hangers of 1⅛-in. iron. Fig. 3 shows this derrick, and the crew preparing to lower one length of 48-in. and one length of 42-in. pipe (side by side). This is at the beginning of the work, near the intake chamber, and shows the end of the new tunnels. The intake chamber is not built up to its full height, but drop pipes from the ends of the tunnels will extend to the bottom of the chamber.

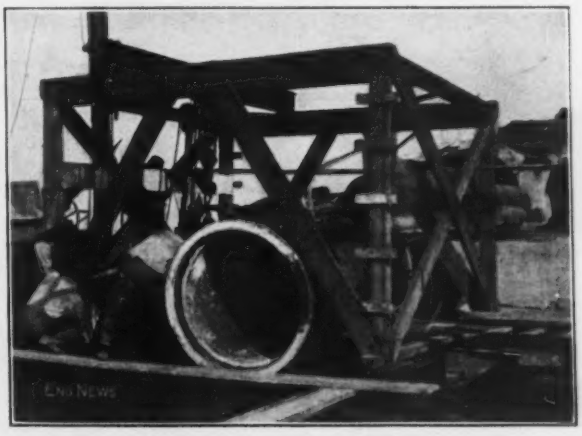


FIG. 3. LOWERING TWO PARALLEL LENGTHS OF PIPE FOR THE SUBMERGED INTAKE AT EAST ST. LOUIS, ILL.

The pipe is then brought to exactly the proper elevation, by turning the nuts on the U-bolts before the diver goes down. A great deal of time is saved by being very careful in getting this pipe at just the proper elevation. Then when the diver goes down, it is a very easy matter to pry the pipe to one side or the other, until it will enter the bell.

Each joint is clamped with four 1-in. eye-bolts, the eyes being attached to a four-part band on the bell of

the pipe, as shown. The bands and eye-bolts are put on the bell end of the pipe before it is lowered into the water, the bolts being tied back to prevent their interference with the joint. The diver puts the bolts between the claws of the lugs, upon which a plate is set, and screws down the nut upon this plate, drawing the pipe home into the bell. Plenty of thread is allowed on the eye-bolt to permit of drawing the pipe entirely home in this way. The pipe was made specially for this job and has the lugs cast upon it, while the bands and eye-bolts, being a simple matter, were designed on the job.

It was found almost impossible to enter the pipe at first on account of the sharp edge of the spigot end cutting or denting the lead ring. To overcome this, it was necessary to chisel off this corner, making about ½-in. bevel, and also to round off the sharp corner of the lead ring. This completely eliminated the trouble, from which it was thought evident that some saving could be made by having this done at the foundry while turning down the taper. It was considered also that it would be advisable if the taper were made ⅛ in. in 5 in. instead of $\frac{1}{16}$ in. in 5¼ in., as this would enable the laying to progress very much more rapidly.

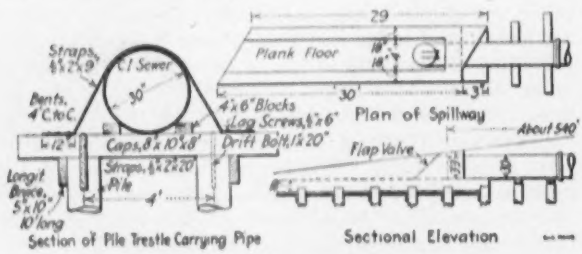


FIG. 4. CAST-IRON OUTLET SEWER THROUGH THE NEW LEVEE AT EAST ST. LOUIS, ILL.

These points are all very important in laying pipe of this size for each pipe weighs four and five tons for the 42-in. and 48-in. sizes, respectively, and must be handled under water by one man, who cannot do very much forcing. It must be handled carefully also to avoid breaking off the lugs. A railway derrick car with a long timber boom was used in unloading the pipes from the cars. The work is being done with the river at a stage of 15 to 16 ft., which makes the top of the pipe about 20 to 21 ft. under water.

The East St. Louis pumping station, referred to above, supplies water to East St. Louis and all its suburbs, as well as Brooklyn and National City (including the packing house and stock-yards district), and also to the Belleville Water Supply Co., which in turn supplies the city of Belleville. The station does not pump water at all times to Granite City, Venice and Madison, although there is a connecting main through which water is supplied to these places temporarily in cases of emergency. The City Water Co. of East St. Louis and Granite City, which is its incorporated name, has been in existence for several years, although it has been and still is divided into two divisions under two different superintendents.

For information as to the above work we are indebted to C. M. Horner, Superintendent of the City Water Co., and W. N. Aubuchon, Manager of the East St. Louis Industrial League.

SEWER OUTLET

The St. Louis National Stock Yards Co. has a cast-iron sewer outlet extending about 400 ft. from a brick manhole to the river bank. The outlet is about 500 ft. below the water intake. It was not considered desirable to simply lengthen this outlet to carry it through the new levee, as the weight of the fill upon it might cause settlement which would dislocate the joints.

Instead of this a new line of 30-in. cast-iron pipe was built from the manhole, supported on pile bents, as shown in Fig. 4. This is 540 ft. long, with a grade of 0.2%, and the outlet is over a pile and rock bulkhead wall built by the Wiggins Ferry Co., which serves to prevent damage by scour. The discharge end of the pipe is provided with an automatic flap valve to close the outlet when the river level rises above the outlet. Beyond this a wooden channel or spillway extends to the edge of the slope.

In connection with this work, the old bridge sewer leading to the manhole was uncovered and examined, and strengthened when necessary by the use of reinforced concrete. As the old manhole is not needed it was closed with a concrete cap and is now buried in the fill.

The work was planned by T. N. Jacob, Chief Engineer of the East Side Levee and Sanitary District, and carried out under his direction. It was completed Nov. 25, 1913, and cost about $8568.

A New Process for the Manufacture of Gearwheels has been developed by Herbert Terry & Sons, of Redditch, England, according to the London "Engineer" of Dec. 12. The finished wheel is built up of a number of stamped discs or laminations of sheet steel or other material of high tensile strength. First the circular disks are stamped out, then the center with keyway (if necessary) and rivet holes, and lastly the teeth. Two sets of disks are so stamped that when the laminations of each are alternated in assembling, the teeth of each disk will exactly bisect the space between the teeth of adjacent disks. In other words, in a gear made up of six disks, three disks will be interlocked one-half of the pitch in advance of the other three. Thin distance pieces are of necessity placed between adjoining disks. The advantages resulting from staggering the teeth are claimed to be as follows: Diminished backlash, less noise, lower cost, and better lubrication. The principal disadvantage is that the above described construction cannot be used in a sliding gear box. For such service the disks would be assembled to make an ordinary spur-gear formation.

The Cost of Eliminating Grade Crossings—"I think we should do more than is required of us at grade crossings so as to halt or deter the sentiment which is sweeping over the country for the elimination of grade crossings, without proper thought of the great economic questions involved. Even now, without taking into account the largest cities, the Baltimore & Ohio System is being forced by resolution, by ordinance, or by the exercise of state laws, to agree to, or submit plans for expenditures aggregating more than fifteen million dollars for the elimination of grade crossings. I have recently made up an estimate of the cost of eliminating grade crossings on our entire system. It would cost about one-half our capitalization to eliminate grade crossings on the Baltimore & Ohio System; about $350,000,000, if we were to start today and finish three years from now. The Pennsylvania R.R. has published a statement that to eliminate all its grade crossings would cost $600,000,000. That means about $1,000,000,000 for only two railway systems of the many in this country. Think of it! A general elimination is impossible. This country is too young and in too undeveloped a stage to allow so much of its resources to be so used. Possibly there may be or will be, in time, a broad economic reason for the elimination of 30% of the grade crossings, but it would be a great waste of the resources of this country to eliminate the other 70%, if some other method could be found to safeguard human life, such as proper laws, thoroughly enforced. Eventually, or as soon as the economic questions are understood, I believe the fairness of the general public will make the division on an equitable basis of the expense of such crossings as may have to be eliminated."—From an address by Francis Lee Stuart, Chief Engineer, Baltimore & Ohio R.R.

The Presidents of Four National Engineering Societies

(With Insert Sheet of Portraits)

SYNOPSIS—For the 21st consecutive year we publish herewith the portraits of the Presidents of four national engineering societies with their biographies. We were unable to obtain for publication a photograph and biography of the President of the American Institute of Electrical Engineers and we have substituted the newly elected President of the Canadian Society of Civil Engineers, M. J. Butler, C. M. G. Three of the Society Presidents, whose portraits we printed a year ago, were professors in engineering schools. The group of men whose biographies are printed below are all men who have won success in active business and professional work.

Hunter McDonald, President of the American Society of Civil Engineers

By Howard M. Jones*

The Vicar of Wakefield exhibited rare wisdom in choosing his "wife as she did her wedding gown—not for a fine glossy surface but for such qualities as would wear well."

In the election of Hunter McDonald to its presidency, the American Society of Civil Engineers has displayed the same kind of judgment. It too often happens that men are promoted to places of honor because of accidental achievement or public prominence, but the above Society has, as usual, conferred its highest honor worthily, on a plain modest man, whose faithfulness to his every-day duty and loyalty and helpfulness to his profession are his dominant characteristics.

Hunter McDonald, the seventh son of Angus W. McDonald and Cornelia Peake (his second wife), was born at Winchester, Va., June 12, 1860, and was named after Dr. Hunter McGuire, who afterward became Medical Director of Jackson's Division of the Army of Northern Virginia. His paternal ancestors were direct descendants of the historic Donald clan of Scotland, the head of the American branch of the family being Angus McDonald (emigrant) who having fought in the battle of Culloden was attainted of treason and fled to Virginia in 1746. For meritorious service in Indian wars he was granted four hundred acres of land by the colony. In 1762 he purchased a tract of land near Winchester, Va., and built his home, calling it "Glengarry" after his old Highland habitat.

Angus Wm. McDonald, grandson of Angus McDonald (emigrant) and father of the subject of this sketch, was born in Winchester, Va., Feb. 14, 1799. He graduated at the West Point Military Academy in 1817, and served in the Coast Artillery until 1819, when he resigned and set out for the western frontier to try his fortune. After eight years of a strenuous life amid trappers and hostile Indians, during which his military training was often brought into play in the border conflicts, he returned to his native state, married, studied law, and established a home at Romney, Va.

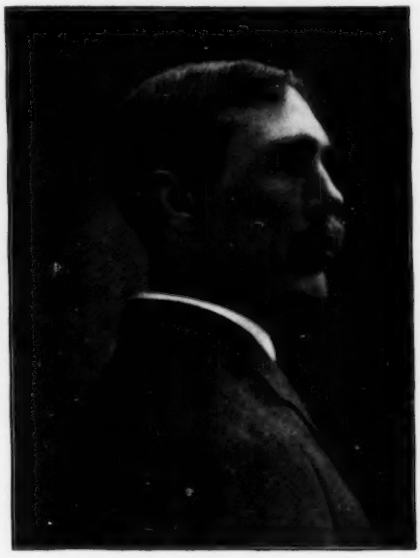
When in 1861 Virginia seceded, and immediately the thunders of the Civil War were heard, Angus McDonald, though the frosts of 62 winters had fallen upon him, hastened to Harpers Ferry and tendered his services to defend his native state. He was commissioned a Colonel and immediately assigned to duty defending bridges and fords along the Potomac near that point. He served gallantly until 1863 when he was captured by the Federals. For a period of more than a year he underwent the trying ordeal of prison life and when finally released his health was so impaired that he died within a week after reaching Richmond, Va. He was the father of eighteen children and though dying at the rather early age of 65 years, his had been a most eventful career and an honorable heritage to his descendants.

Hunter McDonald, born at the outbreak of one of the greatest wars of history, of a long line of military heroes, educated and nurtured during those trying years of reconstruction, when the State of Virginia was impoverished, with its former noble families scattered, shattered, but not despairing, must needs have in his make-up the iron which produces true leaders among men. His work, however, has been in times of peace and he has not been called to wage war against his fellow man, but none the less he has had his fight, for true to his duty he has battled, as does every true engineer, with the forces of Nature, applying such to the uses and convenience of his kind.

Mr. McDonald was taught at home by his mother until the age of eleven years. He then attended the public schools of Lexington, Va., for two years. The family having moved to Louisville, Ky., he entered the Louisville Rugby School, which was in charge of two of his older brothers, and he completed his studies there in 1878. Hon. Oscar Underwood was his deskmate at that institution. Mr. McDonald then went to Washington and Lee University for one year where he pursued special studies in mathematics and engineering. With this scant technical equipment he began his career as a civil engineer. Appreciating no doubt this lack of a thorough foundation for his life's work, he studied the more earnestly and supplemented by hard individual effort what was lacking in his college course.

At the early age of 19 years he entered the service of the Louisville & Nashville Ry. He was placed in charge of a small party to remeasure the main line, relocate the mile posts, and station the track and structures. He started out on this work with two young companions and a negro cook, walking and carrying his camping outfit on a handcar, camping wherever night overtook him. The summer this work was done was exceptionally hot and disagreeable and though some of his companions quit, he secured others and steadily continued his task, covering over one thousand miles of road. During the latter portion of the work the handcar was demolished by being run into by a train and the remainder of the task was finished on foot, the entire party sleeping on

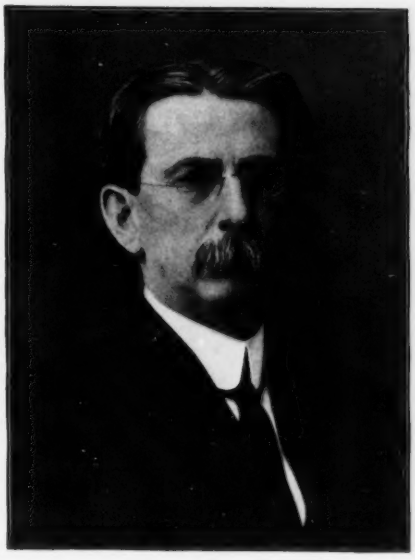
*Valuation Engineer, Interstate Commerce Commission, Municipal Building, Chattanooga, Tenn.



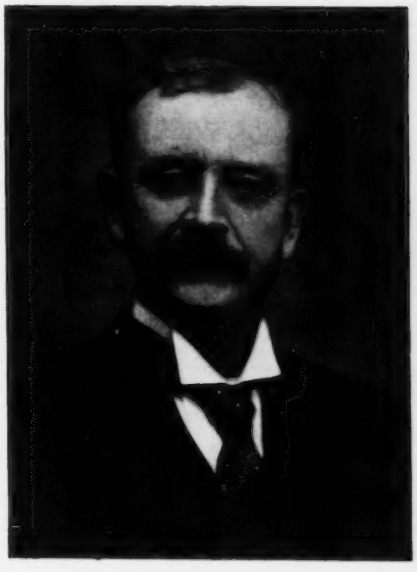
PRESIDENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

PRESIDENT OF THE AMERICAN INSTITUTE OF MINING ENGINEERS

THE PRESIDENTS OF FOUR NAT



PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS



M. J. Butler

PRESIDENT OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS

OUR NATIONAL ENGINEERING SOCIETIES

the ground wherever the day's work ended and procuring food as best they could. The work was finally concluded Nov. 1, 1879, at Memphis, Tenn., where the yellow fever was then raging.

The faithfulness with which this task was performed was early evidence that the young man possessed the metal and mental caliber necessary to make a successful engineer and a leader.

On Dec. 1, 1879, Mr. McDonald was made Assistant Engineer of the Nashville, Chattanooga & St. Louis Railway under Col. R. C. Morris, then Chief Engineer, and he was the only assistant engineer on the system at the time. He has been continuously in the service of that railway until the present time and has established a record of faithful, efficient service rarely equaled. His specific achievements in the development of this great railroad property are too numerous to outline in detail, and only a few of his accomplishments can here be given.

In 1884, Mr. McDonald was placed in charge of the rebuilding of Running Water Viaduct, one of the most important bridge structures on the line, being a viaduct 820 ft. long with height of 110 ft. The old structure of Phœnix columns, Fink trusses with wooden top chords, built in 1867, had become inadequate under the increasing weight of rolling stock, and was to be replaced by one of steel throughout and of heavier type. One of the main problems connected with the work was the securing of satisfactory foundations, and although quite young in years the judgment he displayed was accurate and no trouble was ever had on account of settling footings, although the steel structure was on several occasions strengthened to take care of the ever increasing weight of rolling stock. It is significant of the rapid development of this railway that this structure is now being rebuilt as a double-track bridge on a new location in order to accommodate the heavy traffic and large engines which the N. C. & St. L. Ry. is now operating.

Mr. McDonald's next important service was in the location and construction of a number of important branch lines for his company. The Huntsville Branch, the extension of the Sequatchie Valley Branch, and the Tennessee and Coosa R.R. were among the number. He also performed in a masterly way the task of rehabilitating and rebuilding, under traffic, several roads purchased by his company, among which may be mentioned the work on the Duck River Valley R.R., changing from a narrow to standard gage; reducing the curves from 22° to a maximum of 12°; shortening the line considerably by cutoffs and reducing the grades.

In 1891, the Nashville, Chattanooga & St. Louis Ry. leased from the State of Georgia the Western & Atlantic R.R. between the two important centers of Chattanooga and Atlanta and forming a valuable outlet to the southeast. At the time the W. & A. was in such a condition that operation of even the lightest engines over it was extremely hazardous and before an increase in traffic could be thought of it had to be completely rebuilt. Mr. McDonald was assigned this task and under his direction every bridge (including in many cases the masonry) on the line, and these are a great number, was renewed. New and heavier rails were laid; new ties put in; crushed-rock ballast placed as rapidly as it could be secured; new station buildings were erected or old ones remodeled, and many new sidings and other improvements made, and all the while traffic was moving in a steadily increasing amount.

Col. R. C. Morris died in November, 1892. Mr. McDonald, then only 32 years of age, was appointed Chief Engineer to succeed him. Certainly an unusual honor for one so young, but one richly merited by his accomplishments for his road.

One of the first important matters to engage his attention after being made Chief Engineer was the construction of the drawbridge over the Tennessee River, at Johnsonville, Tenn. This required the building of three new piers. The old bridge had been carried on light piers resting on grillage founded on the gravel bed of the stream. The requirements of the War Department made it necessary to put in a draw which would furnish two clear spans of 180 ft. each. As much scouring had taken place around the old piers, it was decided that all new masonry should be carried to rock foundations. This necessitated pneumatic caissons, which were carried to a depth of 44 ft. below low water. The entire work was done in such a masterly way as not to interfere with the traffic of the road. Upon its completion Mr. McDonald presented to the American Society of Civil Engineers a paper giving a detailed description of this work, which was a most valuable contribution to the engineering literature of the time.

After an era of great railway expansion came the panic of 1893 when construction work came to a standstill. Mr. McDonald then turned his attention to a closer study of reducing costs of maintenance and operation. The lines in west Tennessee had been built originally when timber was cheap and miles upon miles of pile trestle were in the main lines. Under his direction studies were made looking toward the elimination of these expensive structures and converting them to permanent way by filling. After submitting an exhaustive report on the subject Mr. McDonald was permitted to go ahead with his policy, the result of which was that in a few years the cost of maintaining bridges on these lines was reduced more than 50%. Numerous reductions of grades and cutoffs were also made, and 35 miles of its main line double tracked. For the past ten years the N. C. & St. L. Ry. has continued to make extensive improvements on all its existing lines so that today it stands in the forefront of the railways of the South in the physical character of its property, the safety of operation, and the solidity of its investment. No history of this property can be truly written without recording the notable works of Hunter McDonald.

At the time he became connected with it, the N. C. & St. L. Ry. had only 453 miles of track and today 1231 miles are operated. The train mileage, then 1,500,000, is today 7,400,000. In the 34 years of Mr. McDonald's service no accident or wreck has occurred which could be charged to any fault of the maintenance department, and the life of not a single paying passenger has been sacrificed on its main line.

Mr. McDonald has in his busy life, however, found time for service outside of his own road's work. In 1900, the Southern Ry. had an awful disaster at Camp Creek, south of Atlanta, Ga. A train ran into a washed-out arch culvert and was completely wrecked, 34 persons losing their lives. Mr. McDonald was employed to make an investigation as to the cause of the disaster and to ascertain whether or not it was due to any negligence or fault of the railway. It was an important case involving not only a possible verdict against the railway of over half a million dollars in damages but also the

vital principle as to how far the courts would say the railway should go in designing water-ways to provide for the cloudburst which would probably not occur once in 50 years. So exhaustive, fair and conclusive, was his report, showing that the rain which caused the washout was unprecedented and that all usual and practicable precautions had been taken by the railway company, that the first test suit resulted in favor of the defendant, while others were compromised.

In 1906, Mr. McDonald was the moving spirit in the organization of the Wholesale Merchants Warehouse Co., of Nashville, Tenn. This company built a reinforced-concrete tunnel costing over half a million dollars, which is served directly by the L. & N. Terminal Co. tracks. The problem was unique in that it meant the moving of a considerable portion of the jobbing business of the city to an entirely new location a mile from where it had flourished for half a century. However, the great advantage to the merchants of being able to receive and forward their goods direct from their places of business without any drayage or handling charges was so attractive that all buildings were soon occupied. Mr. McDonald supervised the entire construction of these buildings and is the General Manager of the operating company.

Mr. McDonald has ever appreciated that an engineer should be helpful to his fellows and though having always been a busy man, he has found time to be of great service in engineering society work.

In 1882, he was elected a junior member of the American Society of Civil Engineers, and was transferred to full membership in 1887. From 1903 to 1906, he represented District No. 6 as a Director. In 1910, he was Vice-President.

When the movement was started to organize the American Railway Engineering Association, Mr. McDonald was invited to assist and did so in his usual effective way, giving a large portion of his valuable time for several years to put the organization on a firm footing. He was a charter member and the eleventh man enrolled. He was made a Director at its organization, later Vice-President, and President for two years, 1904-1906. It is worthy of note that he has thus within the past ten years occupied the highest position of honor in two of the greatest engineering organizations of the world.

Not only has he served with distinction these great Societies, but he has given even more of his time to the Enginering Association of the South, of which he was one of the founders. This organization is one of the few of the minor societies which has a successful history of 25 years to its credit, and a large measure of its success must be attributed to Mr. McDonald. He has served it as President, Secretary, Treasurer and almost continuously as a Director.

Each of the above societies has greatly profited by the papers presented by Mr. McDonald and few engineers have more cheerfully or freely contributed to the general good by publishing their experience and their views.

He is also a member of the National Geographical Society and the Franklin Institute.

In 1906, he was appointed by President Roosevelt as a member of an Advisory Board to coöperate with the technological branch of the Geological Survey, for testing fuels and structural materials. This Board assisted in the establishment of the present Bureau of Standards.

Mr. McDonald has ever taken an active interest in the affairs of his home city. He is an active member of its various commercial organizations and social clubs.

Mr. McDonald's work during the past twenty years has been accomplished under the handicap of poor health. The qualities of his martial ancestors have kept him on the firing line of active service when many a man would have long since become discouraged and have left the field to others.

In 1893, he was married to Miss Mary Eloise Gordon, of Columbia, Tenn., a great-granddaughter of Col. John Gordon, one of Andrew Jackson's most trusted scouts. They have one son, Hunter McDonald, Jr.

James Hartness, President of the American Society of Mechanical Engineers

By Charles Whiting Baker

Over sixty years ago, a group of bright mechanics gathered around a water power in the town of Windsor, Vermont, and built them a machine shop, in which they proceeded to invent and develop the turret lathe. The firm of Robbins & Lawrence was responsible for the first automatic revolving turret; for the application of power feed to the turret lathe, and for the first development of the machine in the field of large work as distinguished from the comparatively narrow field of the so called "screw machine." The history of this firm, which afterwards changed its name with gradual changes of ownership to the "Jones & Lamson Machine Co.," is practically the history of the turret lathe.

For forty or fifty years the firm worked along with varying fortunes, removing in 1888 to the town of Springfield, Vt., seven miles from the nearest railroad station at Charlestown, N. H. Here the pig iron and coke were hauled in by the truck load, and the finished machines were shipped out by the same means. Turret lathes were built in unnumbered styles and sizes, together with engine lathes and various lines of miscellaneous machinery. The firm preserved an excellent reputation, but it did not make much money.

One day in the fall of 1889, the Charlestown stage stopped at the door of the shop and there stepped forth a tall, thin, diffident young man, with black mustache and chin whiskers; and he forthwith proceeded to shape the destinies of the concern—a proceeding which has kept him busy ever since. The young man was James Hartness, whose portrait appears in this issue. The chin whiskers have long since disappeared. They were donned to conceal in some measure the flagrant youthfulness of the wearer; but concealment of his youth was, and still is, impossible; and the evident ability and good sense of the wearer soon made subterfuge superfluous.

This young man of 26 years worked out in this remote New England village a series of mechanical inventions and business policies which have not only won remarkable commercial success, but have, as well, deeply influenced the whole business of machine-tool building. In the first place, after diagnosing the condition of the firm, he prescribed the remedy of specialization, which has since been applied with such marked success by machine-tool builders the country over. "One machine, one size of one machine," was for many years the motto of the firm.

In the second place, he determined to design and build a machine of such marked originality and of such wide range of usefulness that the handicap of remote location would be minimized. The result of this determination, and of careful painstaking study as well, was the Hartness Flat Turret Lathe, which the little town of Springfield has since built in thousands and shipped to all civilized countries of the globe.

As a third item of improvement he worked out the scheme of selling directly to the customer, and maintaining a corps of trained operators to take care of the customer and of the machines after the sale was made. The carrying out of this idea (then a comparatively new one in the machine-tool business) resulted in a closeness of contact between the customer and the maker that worked to the advantage of both, and thus fulfilled the requirements of an ideal business transaction.

In addition—as years went on and he gained in experience—he has developed other principles in shop management which have proved to be undisguised blessings to employer and employee alike.

For the results of his mechanical ability, the reader is referred to the broad field of work performed by the modern turret lathe as compared with its restricted range 25 years ago—an improvement for which Mr. Hartness must be awarded a large share of the credit. For his achievements in shop management—particularly on the side of the study of the employee as a human being rather than as a "hand"—a reading of the introduction to the "Flat Turret Lathe Manual," and of his book on "The Human Factor in Works Management" will be profitable and illuminating.

A visitor to Mr. Hartness' home in Springfield sees about him other evidences of the wide range of his interests. He will find the slopes back of the town dotted with some hundreds of thousands of young pine trees, set out with enthusiasm and watched with fatherly care. He may drive through endless winding roads over the timbered hills to the east of the town, coming here and there upon picnic shelters, seats and cleared outlooks from which forty miles of the backbone of the Green Mountains are visible to the west of the town. Blue enamel signs assure the visitor that he is welcome so long as he does not injure the trees, frighten the birds or shoot the squirrels.

On the lawn at one end of his house stands a curious structure—a sort of ossified elephant with cylindrical trunk upraised to the heavens. This structure is the scene of Mr. Hartness' chief occupation outside of working hours. It is of his own creation, and he has christened it the "Turret Equatorial Telescope."

One of the discouragements of astronomical work is the fact that observations with the ordinary telescope have to be made at practically the temperature of the outside air. In winter, when so much of the best work may be done, this amounts to something worse than mere discomfort. There is an actual dulling of the senses by the cold, as well as a clumsiness of manipulation which seriously affects the rapidity and accuracy of the observer's work. The Turret Equatorial Telescope was built to provide a station for the observer in a warm, comfortable room; at the same time, it preserves unimpaired the accuracy of the instrument mounting, and involves the least possible optical loss from the required modifications in the instrument. It is the only telescope of its kind which requires but one angle in the line of vision, and this is obtained by total reflection in a prism, instead of by the more troublesome plane m[illegible] type of apparatus. At the same time (another un[illegible] advantage for an instrument of the fixed station t[illegible] practically the whole sky is within range of the [illegible]ment, clear to the polar axis.

The machine is unique in its mechanical [illegible]rection as well, depending for the accuracy of its ho[illegible]notion on a broad turret bearing, instead of the [illegible] small pivots. The whole method of mounting and [illegible]pula-tion is original and effective. The instrument [illegible] com-pletely described in a paper read by Mr. Hart[illegible] before the American Society of Mechanical Engine[illegible] in De-cember, 1911.

It will be seen that the range of interests of [illegible]sident Hartness is remarkable, embracing such wide[illegible] varied subjects as mechanical invention, business mana[illegible]ment, pyschology, astronomy and forestry. This di[illegible]sity of interests gives an added zest and breadth to his conversation, whether with old friends or chance acquaintances.

But there is something further than this for which many men hold him in grateful regard. He has great skill in bringing out the best powers of the men with whom he deals. In his own organization great pains are taken to find the proper place for each man. Failure in one position does not mean summary and irrevocable discharge. Place after place is tried until the round peg finds the round hole and the square peg fits in the square hole. Many of us look back with gratitude to our first meeting with him as young men, remembering the charitable way in which he recognized the enthusiasms and gaucheries of youth, making due allowance for even flagrant offenses, with his eye always fixed on what the young man might become as he grew older.

The subject of this sketch, son of John William Hartness and Ursilla Jackson Hartness, was born in Schenectady, N. Y., in 1861, and is consequently in his fifty-third year. His first twenty years were spent at Cleveland, Ohio, where after passing through the public schools, he undertook practical work in machinery-building plants. The next three years were spent as foreman of a manufacturing plant in Winsted, Conn., and the following four years as foreman and afterwards inventor in a hardware manufacturing plant in Torrington, Conn.

At Winsted, Conn., he met Miss Lena Sanford Pond, to whom he was married in 1885. They lived in Torrington until 1889, when they removed to Springfield, Vt., their present home. They have two daughters, one of whom is the wife of William H. Bearsley, M. D., of Springfield, Mass., and the other the wife of Ralph E. Flanders, of Springfield, Vt.

In addition to his interest in the Jones & Lamson Machine Co., Mr. Hartness is also interested in four other machinery-building companies.

He has been a member of the American Society of Mechanical Engineers since 1891. He served as one of the Managers of the Society from 1909 to 1912, then as its Vice-President, and now is President for the year 1914.

He is a Fellow of the American Association for the Advancement of Science, and a member of the following Associations: Institution of Mechanical Engineers (British), Verein deutscher Ingenieure, Astronomical and Astrophysical Society of America, London Astronomical Society, Royal Arts Society, Boston Chamber of Commerce, and Vice-President of the Western New England Chamber of Commerce. He was granted an honorary

degree of M. E. by the University of Vermont in 1910, and is the author of "Machine Building for Profit," and also "The Human Factor in Works Management." In both these works he has evidenced his keen interest in the psychological problems of industrialism. He is an advocate of specialization as a necessary means of making the best use of man's energies and adapting him to the work as it is today. His chapter on the value of history is an important contribution to the literature on works management.

Charles F. Rand, President of the American Institute of Mining Engineers

By A. R. Ledoux*

Mr. Rand will retire from his year as President of the Institute after the annual meeting in February. A year ago, technical journals announcing his election to the presidency, unanimously expressed their confidence that he was the right man to succeed to this important office, in view of the troublous times through which the Institute had passed during the preceding year. Today the membership is equally unanimous in praise of his achievements, and regretful that by the constitution he is ineligible to reëlection.

Mr. Rand was born in Maine in 1856. After finishing his education, he became Auditor of the Milwaukee, Lake Shore & Western Railway Co., likewise its Treasurer Circumstances called his attention to iron and steel. In 1886, he retired from the railroad business to engage in mining, becoming the executive officer and manager of the Aurora Iron Mining Co., of Michigan. He has a genius for organization and soon found himself in control of a dozen other iron mines in the Michigan Range. For a number of years he operated iron mines, among them the Penokee and Gogebic Consolidated Iron mines. These companies were soon placed on their feet, incorporated in the Tilden Iron Mining Co., the management of which he surrendered when it was absorbed by the Carnegie Steel Co. During those years, he was very prominent on the "Range" and in Milwaukee as well as at Cleveland.

In 1893, he became President of the Spanish American Iron Co., operating in Cuba, and still continues its President, after twenty-one years of service. He was practically the discoverer of the great Mayari deposits, covering over 40,000 acres, and he has been the executive officer of the Panupo manganese property, and others. The aggregation of iron-ore deposits controlled by Mr. Rand in Cuba exceeds over two billion tons.

With a genius for efficiency, Mr. Rand has added to his holdings the necessary railroads, harbors, electric-light and power plants, sintering plants, etc., and has constructed two model towns, so that these Cuban mines are pointed to as among the most advanced in the care for laborers and other employees.

Not alone in connection with iron were Mr. Rand's activities exercised. He was an executive officer of the Monte Cristo properties in the State of Washington, organizer of the Puget Sound Reduction Co., with a smelter at Everett, and organizer of the Federal Mining & Smelting Co., in the Cœur d'Alenes. Only recently, recognizing his genius for organization and his ability to harmonize divergent interests, he has consented to become the President of the Consolidated Copper Mines Co., an amalgamation of the Giroux, Chainman, New Ely, Central & Butte and Butte & Ely companies and others of Nevada. To this he is giving the same careful attention to detail that he exercised in other enterprises.

In 1910, he became a Director of the American Institute of Mining Engineers, and his associates soon came to recognize that this new member, whose voice and manner were always quiet, had a genius for figures. He was soon after made Chairman of the Finance Committee, and quite logically was the nominee of all parties for the presidential office in 1913. During the year, he has shown not only a thorough grasp of conditions as they existed, but a genius for advance. Under his presidency many Local Sections have been started which are active not only in the discussion of local and technical matters, but in promoting the interests of the parent society.

The income of the Institute during 1913 was $4000 in excess of that in 1912; but a yet more important evidence of the renewed life and returning vigor of the Institute is shown in the fact that while in 1912 there were 324 applicants for membership, the number in 1913 was 630. Even this large number will be added to before the annual meeting in February, for President Rand, not simply relying on the efforts of an energetic Membership Committee, has written personal appeals which have brought in at this writing nearly 150 applicants.

Mr. Rand will be the first to disclaim credit for all of the achievements of the Institute under its new lease of life, or to permit any reflection upon past management or past officers. He recognizes, as do all, that in spite of the earnest efforts of his predecessors in office for some years, the Institute had gotten into a rut from which nothing but energetic action on the part of the members at large—whether ill-advised or otherwise, it is not necessary to decide—could lift it. This action culminated a year ago and Mr. Rand came in on a rising tide. He would also agree that he has had not only from the membership at large, but from the Directors and Chairman of the Technical Committees, most adequate support during 1913; but everybody must recognize that a large part of this support has been due to the inspiration of the leader, Charles F. Rand.

*Past-President, American Institute of Mining Engineers, Consulting Engineer, 99 John St., New York City.

M. J. Butler, President of the Canadian Society of Civil Engineers

By C. H. McLeod*

Matthew Joseph Butler, who has this week been elected to the office of President of the Canadian Society of Civil Engineers, is well known throughout Canada as a gentleman of wide engineering experience. He possesses the unusual qualification of a legal as well as of an engineering training.

Mr. Butler was born in Deseronto, Ontario, in 1857, and is, therefore, in his 58th year. Having attained a position of some eminence as a railroad engineer, he deliberately laid aside his professional work and for a period of three years studied law and graduated with the degree of Bachelor of Laws in June, 1897, from the Lake For-

*Vice-Dean, Faculty of Applied Science, McGill University, Montreal, Que.

est University, Chicago, and was subsequently admitted to the Illinois Bar.

Mr. Butler's name is associated with many of the leading engineering works of Canada. His first important position was that of Assistant Engineer of the Kingston & Pembroke Ry., which subsequently became a portion of the Canadian Pacific Railway System. In 1883-84, he was Chief Engineer in charge of the location and building of the Thousand Island Railway, and in 1884-85 was the Chief Engineer of the Napanee, Tamworth & Quebec Ry. On the completion of this work, Mr. Butler was appointed to an engineering position on the Buildings and Water Service of the Atchison, Topeka & Santa Fé Ry.

In 1887, Mr. Butler returned to Canada and for the next three years was occupied as Superintendent on the erection and operation of the works of the Temiscouata wood-pulp factory. Following this, he became Chief Engineer for the Rathburn Co.'s interests, which included the Bay of Quinte Ry. & Navigation Co.; the construction and operation of portland cement works; terra cotta brick works, and the large sawmill and other industrial enterprises conducted by that firm. In 1895, he designed and constructed the Oshawa electric railway, and it was on the completion of this work that he took up the study of law.

On his resumption of engineering work, his first position was as Chief Engineer on the construction of the Hillsboro bridge near Charlottetown, Prince Edward Island; an undertaking of unusual difficulty on account of the treacherous character of the foundations of the bridge, which reached a depth of 97 ft. below mean tide level in five pneumatic caissons.

On the completion of this work he designed and erected the Locomotive Machine Company's works in Montreal and for some years was actively engaged in the engineering and management of these works, now the Canadian branch of the American Locomotive Company.

In 1904, he was appointed Assistant Chief E[illegible]neer of the National Transcontinental Ry. with h[illegible]arters at Ottawa. This position, however, he occupi[illegible]ly for a short time when he was called to the highe[illegible]ce of Deputy Minister and Chief Engineer of the D[illegible]tment of Railways & Canals for the Dominion of Ca[illegible]. For this position Mr. Butler's diversified trainin[illegible]nd experience qualified him in an eminent degree. [illegible]e Dominion Government was, however, unable to r[illegible]n the services of its distinguished Deputy Minister i[illegible]iew of the more lucrative position placed at his dispos[illegible]by the Dominion Iron & Steel and The Dominion C[illegible] companies, of which he became General Manager after five years' service under the Government. As an appreciation of his work while Deputy Minister, he was created C. M. G. by His late Majesty King, Edward VII, for distinguished public services.

In 1912, after some three years' work as General Manager of the Dominion Iron & Steel Co. and The Dominion Coal Co., Mr. Butler resigned his position to take up a general consulting practice with headquarters in Montreal. As Director and Consulting Engineer for the Armstrong, Whitworth Co., of Canada, Ltd., he is in charge of the erection and equipment of the works at Longueuil, near Montreal.

Mr. Butler's solid training in the theoretical side of his work and especially as a mathematician is to a large extent a matter of self teaching. In his early days, while engaged in the active practice of his profession, he is known to have covered the entire college curriculum of the time as the result of systematic reading each day. To no member of the profession is its technical literature more completely known, and he has confessed to having read every copy of the ENGINEERING NEWS since its first beginnings in Chicago as a monthly publication called "The Engineer, Architect and Surveyor," forty years ago.

The Answer to What is the Matter with Irrigation

By E. P. Osgood*

SYNOPSIS—The cost of his land and of his share of the construction of irrigation works is but a small part of the total capital expenditure which the settler on arid land must make before his irrigated farm becomes a going concern. A detailed analysis of capital outlay is presented, from the experience and viewpoint of an engineer-farmer. About $6000 working capital is needed for an 80-acre irrigated farm. This is so far beyond the possibility of the great majority of settlers that the author raises this question: Should not our government not only substitute 20-year or even 30-year payments for the present 10-year payments for irrigation construction charges on United States Reclamation Service projects, but also either "level" (grade) the land for the settler or else loan him $500 for every 10 acres which he levels and seeds?

The most noteworthy fact concerning irrigation enterprises, private or government, is their quite general failure to prove anywhere near the successes anticipated for them by the promoter, the engineer, and the banker. As for the disappointments of the actual settler, upon whom all construction charges fall, his opinions on the subject are seldom learned by others.

The vital point of the whole situation is that the settler does reclaim the land, for he meets every expense of converting the arid desert to the fertile farm. The crux of the whole matter lies right here and I purpose to go into actual analysis of the situation, and see if the cost data and considerations resulting do not throw light on a most disappointing outlook.

The average cost of the works of reclamation has been stated to be, for projects involving storage, about $40 per acre for government projects and about $52 for private projects. It is likely government reclamation will be the more important of the two, considering the fright private capital has taken to itself, so the figure of $40 per acre will be used. This covers the cost of works necessary to bring the water to the farmer's door, as it were,

*Agricultural Engineer, Fallon, Nev.

together with a drainage system adequate to carry off the excess waters.

After this expenditure has been made the relatively simple task of the experienced engineer gives way to a complex task for the inexperienced settler.

Much has been said as to speculation being rife in irrigated land, yet there has been no recognition of the great risks the present-day pioneer faces, as for instance late seeding and consequent failure of the crop to make adequate return; quite frequent utterly unremunerative prices for our best intensive crops—potatoes and onions; nearly complete loss of crop by hail or continued rain; or complete loss by blight. These losses are quite frequent enough to the established farmer; one or two of them to the insufficiently financed settler spells ruin.

This task of reclaiming the land to cultivation represents $100 per acre or more. The "more" is used advisedly. Even with land and water together costing but $45 per acre the ultimate total cost is often $150 and sometimes even $200 per acre.

It has been stated that as low as $5 per acre only might be required, in order for farming to be undertaken, over and above the "engineer's cost of reclaiming the land," which is here taken as $40 per acre. On an 80-acre tract a farmhouse costing only $400 would mean $5 per acre, and since irrigation is intensive in any case not so many hundred acres can be handled from a central plant as the inexperienced estimator might be inclined to figure. Plowing alone about Reno, Nev., carries the custom rate itself of $5 per acre.

The early government monographs on leveling land have placed the cost generally at $5 to $10 per acre, with $15 and $20 per acre as excessive figures. This looked good to the settler, but unfortunately he was to be disappointed. He has found the cost generally $30 to $50 per acre. In the light of experience it is found that even the $10 per acre does not apply to leveling at all, but to land already naturally leveled to the desired shape, while the cost he has had to meet has been that incident to furrowing out for furrow irrigation and ditching for the water. Land lying in natural planes and grades is most frequently found in the narrower valleys that were first put under irrigation. On much of it where the grades run from nearly 1 ft. up to 10 ft. per 100 ft., or even to 25 ft. per 100 ft., as I have seen covered with excellent alfalfa, the furrow system of irrigation is the only one practicable. It is only on these lands, and the choicest of them, that costs can be held to below $10 per acre. The large open valleys now being put under cultivation are more unevenly laid, or even windblown to roughness, and tailboard and fresno scraper are the only tools that have really made good on them for the actual leveling required.

An estimate of preparing for irrigation by border check or by furrow, with no leveling at all, is as follows:

	Cost per acre
Breaking brush by heavy teams and railroad rails and burning	$2.00
Plowing mellow, loamy soil	3.00
Furrows for steep ground or levees for border checks	2.50
Ditching of ranch distributed per acre	2.50
Total cost per acre ready to seed	$10.00

Rocky upland soil or salt-grass and wire-grass bottom land cost up to $6 per acre to plow. The salt-grass land is so tough it is usually left to summer fallow for a year, while if broken up to a seed bed it will cost from $5 to $10 per acre, as ordinarily worked with light 4-horse harrows.

Removal of "rocks" on the upland soils readily runs to $50 per acre, if excessive amounts of them are taken away.

How rapidly leveling cost will mount up will be appreciated by a few considerations. Moving sand loam 10 to 20 ft., only, from the ditch, with "crossfiring" or removal possible in both directions from the ditch, so permitting removal of a scraper of dirt for approximately every 50 ft. travel of a 4-horse team and fresno, is contracted almost regularly at 9, 10 and 11c. per cu.yd. Perfectly level land should not require leveling [resurfacing], yet consider an 80-acre tract level as a billiard table and it would be preferable and necessary, in my opinion, for superior results, to give it a grade. It would best be divided into three long strips, 440 ft. wide by 2640 ft. long, and a chosen lower side excavated 0.44 ft. maximum at the lower edge, and the upper side filled a maximum of 0.44 ft. at the upper edge to establish a uniform grade of 0.2 ft. per 100 ft. for "border" or "strip" checks about 50 to 75 ft. wide and 440 ft. long, or the width of each strip. This would give about 180 cu.yd. of excavation moved to fill per acre. The average haul in each strip by itself would be about 300 ft., or 600 ft. of travel per load, but working the cut of one strip into the fill of the adjacent strip would give about 140 lin.ft. of travel per load, or nearly three times the lineal travel per load compared with ditch work at 10c. per cu.yd. Comparatively, it might be taken at 25c. per cu.yd., or $45 per acre for 4-horse work, but 8-horse fresnos and tailboards would be the proper equipment and ought to put the work down to 15c. per cu.yd., in which case it would cost about $27 per acre. This, with the preparatory cost of $10 per acre heretofore noted, would give a total of $37 per acre for land preparation to the point of seeding and irrigation. Yet the full cost is not yet reached as control boxes and their making and placing, even for flat land, will easily add on $3 per acre, giving a final total of $40 per acre. Again, consider that in dragging hills to fill low ground one acre filled an average of 1 ft. deep would require over 1600 cu.yd. As an acre is closely 208 ft. square, the cost per yard would be at least 20c., or $320 per acre. If one acre were fortunately being leveled down as the other was up then two acres would have been prepared at a cost still of $160 per acre. So the relatively exorbitant cost of 3- and 4-ft. cuts and fills is at once apparent.

The Carson Valley in Nevada looks almost ideal to grade for furrow work, but I was assured by Mr. Henningsen, one of the highly successful automobile farmers now there, that it cost almost always up to $20 per acre to fill swales and runs to get the splendid "lands" or checks of furrows there used. Old alfalfa land in a good system of "checks," with a fall from one to the other, easily shows costs of $25 per acre, or $30 to shape up for sugar-beet work.

The great advantage of the "border" check is at once apparent. Releveling would not be required if about 2 in. per 100 ft. or more grade were present in the border check, as it should be.

The cost of $40 per acre for preparation to the point of seeding is only too generally the cost that must be met on the bulk of the lands that are opening to irrigation, and I put it as a safe dictum that it should be the assumed cost. Yet don't think that this is the only cost

the settler faces. The "Cost of Reclaiming the Land," reservoirs and ditches, etc., add another $40, taking him to $80 per acre, and still the homesteader or settler is not out of the woods for there are innumerable other costs to be met. I will try to tabulate a few of these costs by following the trail and trial of the new settler.

Many of the wiser settlers, with some little money, first come out and size up locations and prospects, and then return to get their families and perhaps their goods. This all requires money but usually it is money well expended. It should be and must be charged to the farmers' cost of reclaiming the desert. For their own safety settlers should be compelled to spend from two weeks to two months selecting land and getting posted. Saving $100 of hotel and livery expenses has cost many a man hundreds and even thousands of dollars. Hiring out a year would be a blessing to almost every settler entering a project, if by so doing he got invaluable experience leveling land and handling water.

Having chosen a location for better or for worse, the well, corral, barn, and home must then follow before the family can establish itself on the farm. Some private road building, bridge making and fencing must also come in here. Time and money must be spent getting in household goods, stock, farm implements, telephone line, chicken houses, etc. Next brush breaking, plowing, leveling, ditching, installing ditch structures and check control boxes can finally be undertaken and the ground made ready for irrigation, releveling, reirrigating and finally seeding.

This statement of sequence of operations is made because nine out of ten of us use our imagination and previous experience so little that we conceive of simply the cost of putting a scraper on the land and then drilling the seed in. Actually, the conquest of the desert is far from simple. A family establishes itself, must feed and clothe itself, spend money for insurance and on acount of sickness, for implements, stock feed and all the other multifarious wants of a family and a farm. All this must be charged to the capital investment required to transform desert land into an income-producing ranch. The greatest question, first, last and always, for this as for any enterprise, is the amount of capital investment required to bring commensurate returns. I do not know that such a complete estimate has heretofore been prepared for the benefit and protection of the prospective settler. Certainly I have not seen one.

The following attempt to summarize these costs will show a total that may well startle many. The amounts given are closely current for Western costs actually called for. Machinery does not include the half-day or more spent in getting it to the farm. Eight miles from town will usually eat up one good day in "shopping" for a small list of required goods or easily add a nominal cost of $5 in time and wages chargeable to a delivery of one ton of material or perhaps only a few hundred pounds. Church, school and town activities make demands on both time and money. The new settlers, theoretically and generally, practically, have not regular income behind them and all current living expenses become a capital expenditure—for one year at a minimum, generally for two years, and quite generally for from three to five years, because the ranch acreage as leveled into production is still less than the 45 to 50 acres required to meet family and ranch costs under usual general conditions,

CAPITAL INVESTMENT FOR AN 80-ACRE HOMESTEAD TO END OF FIRST YEAR OF OC[illegible]TED ON

Initial Outlay for Land:		
Railroad fares to one project, only, direct. Three full at $60		
Three weeks at boarding house, av. $6 each per week		
Livery charges to see openings, etc.		
Government filing fees		
First payment, 10% on $40 per acre construction charges		
Maintenance and operation, 75c. per acre per year		
Household furniture, bedding, etc. (very little)		
Stoves, dishes, tubs, etc.		$835
Family Living Expenses First Year:		
Food, $10 per person per month for four	$[illegible]	
Fuel, $5 per month		
Kerosene lights		
Clothing, average of $25 for each of 4	[illegible]	
Medical and dental services, $4 per month plus $25		
Fire-insurance premium for three years on $400		
Life insurance, premium on $1000	20	
Church 40c. per week and Sunday School 10c. per week	26	
Taxes, personal property only, till "proved up" and poll tax		
Charity, amusements, presents, etc., 50c. per week	13	
Telephone $1.25 per month	26	
	15	847
Farm Expenses per Year:		
Four horses at 33 lb. per day, 24 tons at $8 each, alfalfa, delivered	192	
One cow at 40 lb. per day, 7 tons at $8 each, alfalfa, delivered	56	
Only enough chickens kept to eat up waste	[illegible]	
Horseshoeing, 4 horses each 4 months, 25c. per shoe	12	
Blacksmithing in town, repairs	15	
Stock loss, one $80 cow once in 4 years	20	
Stock loss, one $150 horse once in 6 years	25	
Incidental repairing, hardware, etc.	10	330
Farm Plant and Equipment:		
House, 14x24x10 ft. at 10c. per cu.ft.	336	
Barn, corral, feed racks, etc.	120	
Private road work	20	
Bridges and culverts	30	
Fencing, 1½ miles	180	
Well and pump, 2	80	
Temporary framed tent house	50	
Milk cellar and root cellar	180	
Ditch structures and boxes, $3 per acre on easy ground	240	
Chicken coops, etc.	50	1286
Farm Stock and Farm Machinery:		
Horses, 4 indispensable at $150 each	600	
1 cow, family. One of best investments	100	
2 doz. chickens at $6 per doz.	12	
1 sulky plow	55	
1—4-horse tooth harrow	25	
1—4-horse disk harrow	45	
1 Cultivator	8	
1—5-ft. hay mower	70	
1 Hay rake	40	
1 Farm and hay wagon	130	
1 Spring wagon for market	90	
1 Buggy for one horse	40	
1—4-horse tailboard scraper	30	
1—4-horse Fresno scraper	25	
1 Doan back-up ditch scraper	10	
1 hand seeder	5	
Eveners, clevises, etc.	15	
2 Double work harnesses at $28 each	56	
1 Single buggy harness	15	
Small tools, shovels, pails, forge, carpenter tools, bolt dies, iron, etc., very little	75	
Hay derrick necessary for 30 acres or more	150	
Part Interest in Additional Indispensable Farm Equipment:		
The following are indispensable in their particular work. Many must be available either by renting or borrowing to prevent loss of time or use of money. Seed drill, $100; 2-gang plow, $75; potato planter, $40; potato digger, $150; potato sorter, $25; manure spreader, $160; alfalfa renovator, $70; fanning mill, $30; beet cultivator, $70; beet plow, $40; beet seeder, $60; grain binder, $75; 6-horse double-steel disk harrow for saltgrass sod, $75; wheel scraper, $50; total, $1020.		
Assume only ⅕ interest in above	200	1796
Seeding Ranch:		
Grain, 90 lb. per acre at 2c., 78 acres	140	
Alfalfa, 20 lb. per acre at 18c., 78 acres	280	
Orchard trees, garden vegetables, etc.	10	
Extra labor harvesting, etc., 1 mo.	40	
Extra labor, boarding cost	10	480
Capital requirement to end of first year	$5574	$5574

General Summary of Foregoing Items

Initial expenses	835
Family living expenses first year	847
Farm expenses one year (no depreciation allowed)	330
Farm plant and equipment	1286
Farm stock and farm machinery	1796
Seed for entire ranch and extra labor first year	480
End of first year. Grand total	$5574

particu[lars] those of new projects. This point is of utmost im[portance] and will be taken up again. In considering [capital] required, an average family, say of husband, [wife] and two children, will be considered and presumed [to] come from the East. The accompanying estimate [is] based on attempting an 80-acre tract, which most [often] fits the usual requirements.

The [total] of $5574 expenditure at the end of the first year [is] startling to those who can appreciate the real significance and meaning of it as affecting the prospect of the [actual] reclamation of our arid lands. It might be said that every single expenditure noted necessarily may not [be] in the first year, but as it must come before the farm [is] reached a self-supporting basis it makes no difference [in] conclusions.

If it is true that expenditures run so large on reclaiming land by irrigation, the next essential question is as to whether the land will make commensurate return. This can best be taken up by considering what will be the probable actual returns from crops put in after incurring the expenses noted. The estimate will be based on returns from alfalfa. This crop is taken because it can hardly be gainsaid that alfalfa has been at the bottom of irrigation success in the past and will continue to be so in the future on arid land requiring the introduction of humus. Alfalfa hay is assumed as worth $8 per ton in the stack. This is more than it sells for at times in a few places and much less than it generally brings, but it is the probable close maximum price that feeders can afford to pay for topping off free range-fed stock.

The estimate to follow assumes the settler to get in 15 acres the first year and 20 acres each year thereafter. Building, fencing, etc., take much time and study of the work entailed and actual results heretofore confirm 15 acres as about all that can be expected to be leveled up the first season; even that cannot be done if the settler is not well financed. The estimate follows:

CROP RETURNS FROM AN 80-ACRE HOMESTEAD

First Year:	Gross
15 acres, 1½ tons grain hay (or ½ ton grain) each at $15 per acre	$225
15 acres, pasturage at $2 each	30
Total first year	$255
Second Year:	
15 acres old alfalfa at 5 ton each at $8 per ton	$600
20 acres grain hay at 1½ ton each at $15 per acre	300
35 acres pasturage at $2.50 each	87
Total second year	$987
Third Year:	
35 acres old alfalfa at 5 ton each at $8 per ton	$1400
20 acres grain hay at 1½ ton each at $15 per acre	300
55 acres pasturage at $2.50 each	137
Total third year	$1837
Fourth Year:	
55 acres old alfalfa at 5 ton each at $8 per ton	$2200
20 acres grain hay at 1½ ton each at $15 per ton	300
75 acres pasturage at $3 per acre	225
Total for fourth year	$2725

The final question of net return can best be approached by means of a cost statement of raising alfalfa, as follows:

COST OF RAISING ALFALFA PER ACRE PER YEAR

Irrigating 5 to 7 times	$2.00
Mowing at 75c. per acre, three times	2.25
Raking and cocking, three times at 60c. each	1.80
Hauling and stacking 5 tons at $1.50 per ton	7.50
Project maintenance and operation	0.75
Ranch maintenance and operation on ditches, boxes, etc.	0.25
Taxes, 3% on a $35 per acre valuation	1.05
Depreciation on $1000 of buildings and tools at 10%—78 acres	1.30
Total cost per acre	$16.90
At 5 tons per acre cost per ton	$3.38
Net return per ton	4.62
Gross return in stack	$8.00

NET RETURN FOR ALFALFA PER ACRE

Five tons at $4.62 per ton	$23.10
Pasturage at	3.00
Total net return	$26.10

Actually quite a number are taking 6, 7 and 8 tons per acre from their ground. As far as seeded, my partner and I are taking 7 tons per acre. It is only too true that 90% or more of the settlers do not approach the 5-ton figure. What we want to get at is why they do not.

The foregoing figures ought to point the moral and adorn the tale. Apparently conservative statements credit 80% of the settlers with being failures in a practical sense; actually the figures are probably much worse. How can one expect it to be much different? The average $1000 or $1500 capital of the average settler cannot be stretched into $3000 to $6000, and he might much better and more safely speculate outright on known high-grade mining securities or other stocks. But to the man with $6000 of capital it is a different matter. An irrigated farm represents about $100 of investment per acre, and can offer $26.10 per acre net profit. Certainly 26% on money should look attractive and is a prize worth working for, yet anyone with less than $3000 capital should be dissuaded from attempting to win the prize, at least if he has a family. The greatest surprise is what has been done with so little capital by those who are now on irrigated land. Many persons with the experience gained during three or four years' work have developed ability and acuteness that have commanded respect and aid and are slowly forcing success their way year after year. One of the gravest misfortunes to a project would be the needless sacrifice of these our most experienced settlers, now understanding irrigation problems and now capable of reclaiming land at a minimum of cost if they had the capital required.

The figure before given of $5574 of capital expenditure by the end of the first year would rise to $6496 just before harvest at the end of the second year if the return of $255 the first year were set against the yearly ranch costs of $1177 and if no store account was carried by the merchant in town. It is thus seen that failure of the land to go into production as anticipated the second season would throw an additional $1000, approximately, into the capital expenditure column. This is precisely what has happened again and again, particularly with the heavier adobe and slightly alkalied soils; it is what first started the movement for a graduated scale of payments on reclamation projects some five years ago.

If the foregoing is a fair statement of problems from the settlers' point of view, is it to be wondered at that the question, "What is the Matter with Irrigation?" has come up again and again? I assert that there is nothing the matter with irrigation; that it offers 25% on the money invested; that it is only too bad the settler was invited to attempt his task with $1000 when he should have had $5000.

A grave situation confronts reclamation progress. No general improvement for years to come can be anticipated so long as the settler must come in underfinanced. Under such a condition the aim of the Reclamation Act is being defeated. One family, perhaps more, bids fair to be wrecked and broken up to make the success of some other family. This is quite as true of private projects as of government ones. "Crops" of settlers is a byword.

As to what can be done it would seem well worth while to study the success of the Mormon Church's colonizations from time to time in Utah and what has been and is being done in Australia in preparing the land, building houses, fencing, etc., for the settler and charging it up to him on ten-year payments and 6% interest. Our average settler has perhaps 30 acres in at the fifth year. Say he averaged 15 acres in for those five years, then at $25 net per acre per year he got net returns per year of $375, hardly enough to meet his water payments. Now consider if he had his 80 acres all in for the same time (or 78 acres net) at $25 net per year, this would have brought in $1950 net per year, or $1575 more per year, or $7875 more for the five years if the whole ranch had been in production. The economic fallacy and waste of allowing leveling to be extended over years and years of time is only too apparent. Forty dollars can be spent to reclaim the land by reservoir and ditch but why not spend $40 more per acre and seize the enormous profit possible on the above basis? Promoters might well study the foregoing figures. Perhaps irrigation bonds could again be sold if the lesson were put into practice. The utter inadequacy of merely changing the 10-year payments for irrigation construction charges to 20-year payments, or even to 30-year payments on government projects, should be appreciated. Prior leveling of the land or immediate loaning of $500 to the settler for every 10 acres leveled and seeded is worth considering.

If the Reclamation Service can get adequate help for the settler its irrigation work probably has the most brilliant future before it of any branch of engineering. Its handling of maintenance and operation is being appreciated, and is probably here to stay. Complete development of the ultimate possibilities of drainage areas would solve almost all the endless litigation in prospect on account of unstored waters. The development is national in character. Private capital has forsaken its opportunity, and it seems to be up to the National Government to determine whether it shall take the field for its own. Financing the settler is the key to the situation.

A Large Steel Water Tank

A steel tank 100 ft. diameter and 50 ft. high, with a capacity of 2,938,000 gal., is being built at Youngstown, Ohio, in connection with the water-supply service. The design is shown in Figs. 1 and 2. There are ten rings of plate, with double-strap butt joints for the vertical seams. These have ten rows of rivets (staggered) in the first two rings, eight in the third, six up to the eighth ring, four in the ninth and two in the tenth or top ring. There is a 20-in. inlet pipe with lead- and oakum-calked joint in the bottom plate, and a 24-in. overflow pipe of ⅜-in. riveted plate.

The shell plates varying in thickness from ⅜ in. at the top to 1⅜ in. at the bottom, and the rivets vary from ¾- to 1⅛-in. diameter. Except in the ornamental part of the hand-rail there is no metal less than ⅜ in. thick, as compared with ¼-in. which is the usual minimum. All plates are made of open-hearth steel in accordance with the Manufacturers' Standard Specifications for railway bridge steel. The maximum unit stress does not exceed 12,000 lb. per sq.in. of net section at the bottom of any course of side plates. The bottom plates are ½ in. thick, and are joined to the sides by a 6x6x1-in. angle on the inside of the tank. By placing the angle on the inside the calking edges are so located that water does not get between the angle and the plates.

Rivet holes in plates $\frac{9}{16}$ in. or less in thickness are punched $\frac{1}{16}$ in. larger than the nominal diameter of the cold rivet. Rivet holes in plates ⅝ to ⅞ in. (inclusive) are sub-punched $\frac{1}{16}$ in. less in diameter than the cold rivet and reamed to a diameter $\frac{1}{16}$ in. greater than the rivet. In plates thicker than ⅞ in., the holes are drilled from the solid.

The tank is built without a roof, but has around the top a steel balcony with hand-rail. This balcony not only serves as a walk but also acts as a horizontal girder to stiffen the top of the tank. There is an outside stiffening ring on the eighth course, consisting of an angle 6x4x½ in. and a filler 4x⅜ in. There are no anchor bolts, the weight of the tank being such that the structure

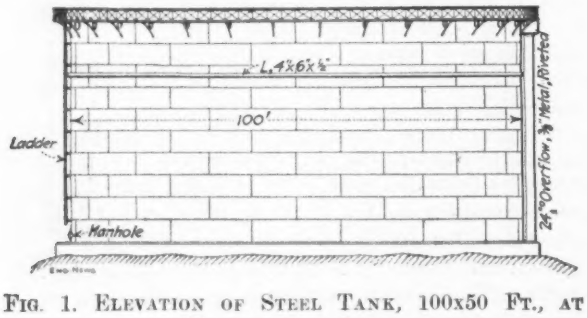


FIG. 1. ELEVATION OF STEEL TANK, 100x50 FT., AT YOUNGSTOWN, OHIO.

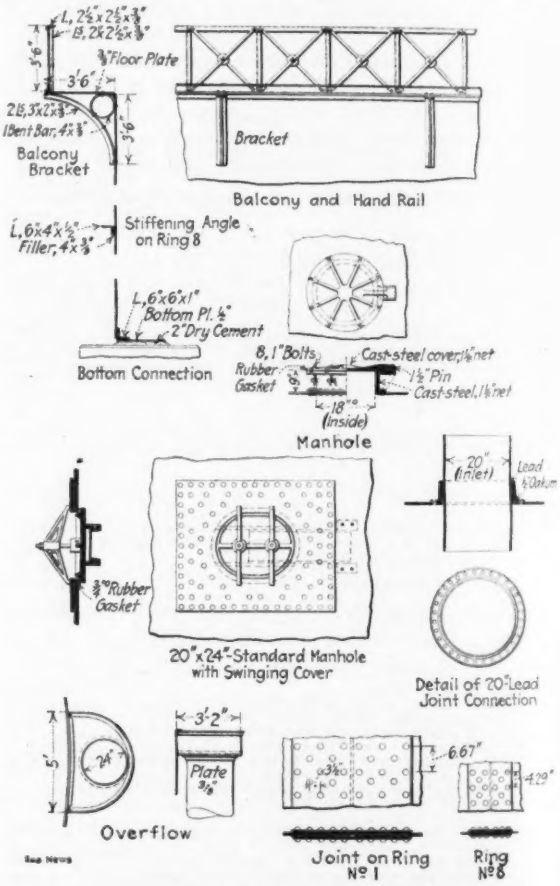


FIG. 2. DETAILS OF TANK

is stable against wind pressure even when entirely empty.

The riveting is done with a large compression yoke except that the riveting of the bottom and the balcony is done with air hammers. The yoke riveter is supported from a stiff-leg derrick, as shown in Fig. 3. The base of this derrick is pivoted in the center of the tank and each stiff-leg is mounted on a small truck riding on a circular track, so that the boom and derrick frame can revolve through a complete circle. The power plant for the compressor and hoisting engine are located just outside the tank. The estimated weight of the tank com-

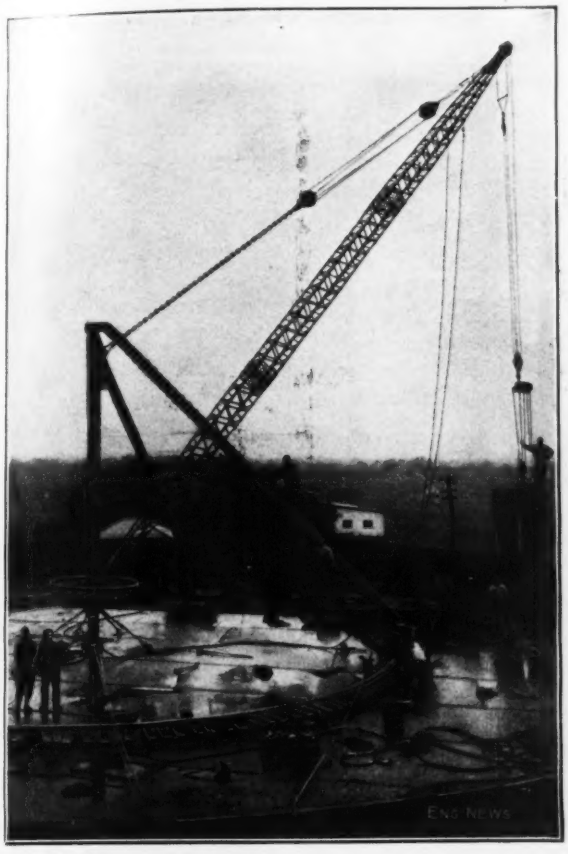


FIG. 3. ERECTING THE 100x50-FT. TANK AT YOUNGSTOWN, OHIO

(The yoke riveter is carried by a revolving stiffleg derrick.)

plete is approximately 500 tons, and there are about 70,000 field rivets.

The work is under the direction of Veeder Heasley, Director of Public Service, and the general specifications were prepared by F. M. Lillie, City Engineer. The tank is being built by the Chicago Bridge & Iron Works, of Chicago, which prepared the detailed plans and specifications.

The Reduction in the Cost of Measuring Base Lines

Most of our readers interested in topographical surveying work are doubtless familiar with the great reduction in the cost of base-line measurements which has been effected by substituting tapes and wires of invar metal in the measurement of base lines in place of the cumbrous bars which were formerly used. Engineers whose work only occasionally brings them into contact with surveying, however, may not appreciate how greatly the cost of accurate topographic surveys on a large scale has been decreased by this comparatively recent development.

In our issue of Mar. 16, 1911, we published a paper by Wm. Bowie, Inspector of Geodetic Work for the Coast and Geodetic Survey, and Chief of its Computing Division, read before the Washington Philosophical Society, explaining the changes which have been made on the Coast Survey in the substitution of tapes and wires in place of bars. At the recent annual meeting of the American Association for the Advancement of Science, at Atlanta, a paper was again presented by Mr. Bowie in which he more fully covered this subject.

According to Mr. Bowie, not since the beginning of the present century has the Survey made use of the old bar method for measuring its base lines. This change of practice, however, has not been fully appreciated by the textbook writers at least, as treatises on surveying published in recent years describe the use of bars as if they were still a practical tool of the engineer. Mr. Bowie concludes his paper with the remark that base-line measurement bars from now on should be found only in museums and deserve a prominent place only in the history of geodetic surveying.

With the modern invar tapes or wires the cost of base-line measurements by a survey party averages only about $50 per kilometer. The work is of a high degree of accuracy, quite comparable with that obtained by bar measurement. This means that in any geodetic triangulation net, base lines can be introduced with much greater frequency, so that in order to secure a given degree of accuracy it is not necessary to introduce as much refinement in measuring the angles of the triangles.

The invar tapes used by the Coast Survey have proved to be much less susceptible to injury in the course of use, resulting in change of length, than was at first anticipated. Mr. Bowie gives values for the constancy of length of four invar tapes used on the Coast Survey, showing that the total range in value during four years for the four tapes varied from one part in 170,000 to one part in 410,000. The difference in length between the values resulting from the length when first standardized and when last standardized varied from one part in 170,000 to one part in 1,110,000. Another great advantage in the use of tapes over bars is that they can be handled by comparatively unskilled persons. In a party of six assigned to base-line measurements, only one or two of its members need to be experts in base-line work, a very different condition from that prevailing with the micrometer bars formerly used.

Relative Weather Resistance of Concrete and Stone—"The claim advanced in the paper that concrete will weather better than good sandstone and almost if not quite as well as granite is hardly to be expected from an experienced observer of concrete work. If the authors know of any formula that will produce concrete with such a desirable quality, they should give it to the profession. It is a poor quality of building stone that will not hold its surface and its edges better than the best concrete. The statement in the paper sounds a little over-enthusiastic. The friends of concrete will promote its use more effectively by avoiding extravagant claims for it."—H. H. Quimby in discussion of design of concrete bridges. "Proceedings of the American Society of Civil Engineers," Jan. 1914.

The Extensometer in the Hands of Practical Men

By Rudolph Welcker*

The word *extensometer* does not appear in the vocabulary of the average person. Its existence is unsuspected. To most engineers it conveys an indistinct idea of some kind of laboratory toy. Only the professor of Applied Mechanics and the assistant in a testing laboratory use extensometers as common tools.

The reason for the lack of appreciation of the extensometer are twofold: (1) It is unknown as a practical tool; (2) theoretical assumption governs modern design, and the test of its truth lies in the stability of the structure. If the work stands up we accept it as the proof of our efficiency; if it comes down, somebody will discover a flaw in the execution of our plans. We figure our structures, determine the stresses in all details and establish dimensions accordingly. The work of the designing engineer ceases; his task is finished. The electrical engineer has his refined measuring instruments, the mechanical engineer uses his steam charts, but the structural engineer does not seem to need any tool to test his interpretation of the theory. He appears [illegible] as long as the work stands up.

There is no doubt but that a lack of prac[illegible]esting instruments has retarded our knowledge o[illegible]ctural stresses. And there is no doubt but that th[illegible]ess of the different branches of engineering is propo[illegible]ate to the efficiency of their respective tools.

In the accompanying pictures (Figs. 1-3) [illegible] shown some extensometers being used in practical [illegible]nding, by engineers in the field. They record graph[illegible]ly the stresses in various structures from a rail t[illegible] steam boiler. The instrument in use is clamped to [illegible] rails during active operation. It has proved its [illegible]ciency under the weight of continental express trains [illegible]nning at 50 mi. per hr. The diagrams are just as clear and accurate and of the same precision as if they were taken in the laboratory of the learned professor. Handled by men in the field under ordinary service conditions, it records with precision and nicety the actual stress in the rail and the wheel-load which caused it.

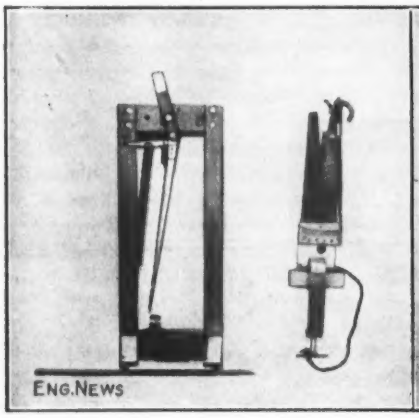


Fig. 1. Nonrecording Strain-Gage Used in Holland for Boiler-Inspection Work

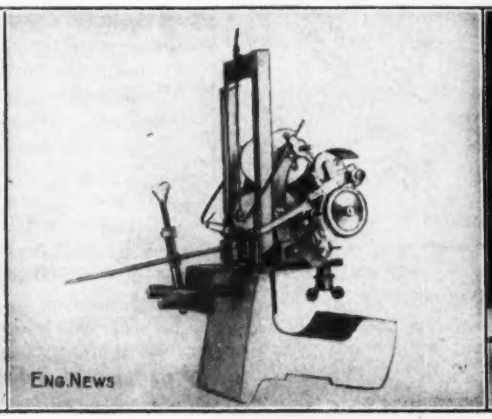


Fig. 2. Latest Model of Recording Strain-Gage

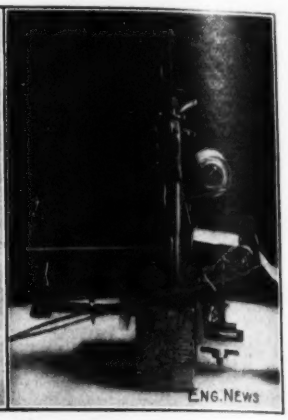


Fig. 3. Attachment of Recording Strain-Gage to Rail

Careful study of the diagrams which this instrument traces will reveal the effect of the moving train load upon the rail, and will show up defects which may develop in track construction. The diagrams can show not only where the rail section is too light but also where joint plates are defective or superelevation impractical. After careful examination the rail becomes a subject of scientific interest instead of only a commercial article worth $28 a ton.

The amount of information collected in this manner is so extensive that it is impossible to give in this space more than the faintest outline of its conclusions. Only the following two are given:

(a) Under certain conditions of track and rolling stock, stresses caused by unbalanced engines may far exceed the stresses caused by direct vertical wheel-load.

(b) A change in distribution of loads over the different axles will affect the life of both track and rolling stock, even if the total weight of the engine remains the same.

The instrument shown in Fig. 1 was first used about ten years ago, by a Dutch engineer, Okhuizen, for the inspection of steam boilers in accordance with regulations. Since 1905, it is in daily use by the governmental bureau

*Designing Engineer, 33 Lyman St., Springfield, Mass.

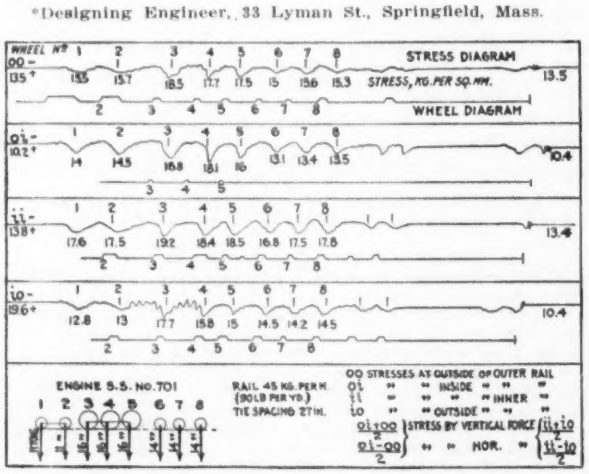


Fig. 4. Rail Stresses Measured on Good Track under High-Speed Train, Netherlands State Railways

supervising the safety of railroad structures in the Netherlands, to whose chief engineer, Schroeder Van Der Kolk, the writer is indebted for all information concerning this matter, and who personally attended all tests which the writer made under his guidance. In the Netherlands, the railway companies anticipate possible accidents and carry out inspections and examinations frequently. The important companies now use extensometers.

When we consider the great care with which a systematic and exhaustive examination is made of the structures coming under the supervision of this bureau, very often upon special request of the railroad companies concerned, the question arises what the United States government does to show its interest in the safety of the railroad structures, or whether this is only a matter of State regulation? Do the Public Service Commissions exercise this function? Do they examine the structures before failure? Of course it is a matter of common knowledge that the commission inspectors are on the job *after* every accident.

In the preceding lines a large field for the application of the extensometer has been shown, of vast human interest. However, there are other fields for its use, e.g.: examination of structures under test load, as bridges and buildings; inspection of steam boilers; all questions pertaining to bridges after accidental damage or before admission of new types of engines. It may be said without exaggeration that the use of the extensometer is unlimited in its possibilities in the engineering field.

Its importance in railroading has been shown, since the abuse to which the instrument is subjected when clamped to a rail is the most severe test. Besides this, the results attained concern directly the safety of human life. As another example of great importance, we may mention the examination of boilers, especially where reinsurance is often refused on account of the length of service of the boilers.

To sum up the advantages connected with the use of extensometers in the structural field, the diagram of the extensometer can and should become just as valuable as the steam chart, to men of theory and of practice, to the engine builder and the operating owner alike. Both records present precise and permanent pictures of the forces at work inside the structure. They can be examined at any time and show a condition of strain at all stages of loading. Both records can be taken by men unschooled in the science of design.

A Zone System of fares has been ordered for the street railways of Milwaukee, Wis., by the Wisconsin Railroad Commission on request of the Milwaukee Electric Ry. & Light Co. At the same time the rates on the interurban lines have been revised by a 2-c. mileage basis. Rates within the city are undisturbed, and the present city-fare limits are retained. All existing outside zones are abolished. Beyond these the suburban territory is divided into zones of approximately one mile apart. Outbound passengers, on entering a car, will deposit 5c. cash or a 5-c. city ticket. On leaving the car they will deposit 2c. cash or a 2-c. zone ticket for each zone into or through which they travel. Inbound passengers will pay to destination as they enter. Passengers riding in suburban territory only will pay 2c. cash, or a 2-c. zone ticket, for each zone into which or through which they ride, but the minimum cash fare is 5c. The zone limits have been established at well marked points, which passengers may easily distinguish. This readjustment decreases the fare to some sections and increases that to others, removing in such cases undue burdens and taking away unpaid benefits.

Pulverized Coal as a Fuel for Boilers*

By R. C. Carpenter†

The continually increasing price of fuel oil has led quite recently to extensive experiments in the use of pulverized coal as a substitute for liquid fuel for use under boiler furnaces and in various arts.

During the last 20 years attempts have been made from time to time to introduce processes for burning pulverized coal in boiler furnaces, but none of these attempts have met with permanent commercial success. Although for more than 30 years the burning of pulverized coal has been suggested as a superior method of utilizing the heat of the coal, up to the present time the process has met with success only in one industry, that of the manufacture of portland cement.

Numerous patents have been issued on machines of nearly every type imaginable for pulverizing coal and delivering the same into a furnace, so that the field of invention relating to the art may be said to be well explored.

The portland cement industry as developed in this country employed a long rotating cylinder known as a "rotary kiln" lined with fire brick for the furnace in which the raw materials entering into the portland cement were burned. This kiln was introduced into practical use about 1890, and as then built was about 5 ft. in diameter and 40 ft. long. Its use has continued up to the present time although it is now built in sizes as large as 10 to 12 ft. in diameter and having lengths from 150 to 200 ft. This kiln is especially adapted for gaseous or liquid fuel, the latter delivered into the furnace in the form of spray. The success of the rotary kiln in this country during its period of development from 1890 to 1900 was largely due to the use of fuel oil, which was employed almost universally until the year 1900. At that time the price of oil had become so high that it was necessary to develop other fuels. Experiments were instituted as early as 1896-1898 looking to the burning of pulverized coal as a fuel, and such experiments were prosecuted vigorously by at least two of the portland cement companies for several years. At that time the writer was consulting engineer for a portland cement company and directed an extensive series of experiments extending over two years of time looking to the perfection and development of a system for burning pulverized coal in furnaces. Successful systems for burning pulverized coal were developed independently by Hurry & Seaman of the Atlas Co., and by myself, both of which systems were patented; later the patents were obtained by the North American Portland Cement Co., which now controls them.

The burning of pulverized coal, at first sight, might appear to be merely a modification of the old method of burning fuel oil, but practically great differences exist. The methods primarily employed in burning fuel oil gave little information useful in the development of a process of burning pulverized coal, as was learned from practical experience. It required many experiments carried through a long period to understand the underlying principles which were essential for the burning of pulverized coal in portland cement kilns.

The general underlying principle which was found essential to the burning of pulverized coal and which had previously been unknown was that the combustion must be completed while the fuel is in suspension in the air. The application of this underlying principle requires a proper preparation of the fuel as to fineness of grinding and as to dryness, and it also requires a combustion chamber of proper dimensions to permit the burning of the fuel in suspension. Other conditions necessary are proper temperatures of the combustion chamber and the proper supply of air for combustion purposes.

The machinery employed in portland cement plants consists of a dryer for removing the moisture and a pulverizer capable of reducing all the coal fine enough so that 95% will pass a standard sieve of 100 meshes to the lineal inch. It was found from experience quite impossible to thoroughly pulverize coal unless it had previously been dried. In the cement industry the dryers employed are large rotating cylinders usually 6 ft. in diameter by 60 ft. in length and kept at the proper temperature by heat applied to the lower portion of the shell. In some instances the flue gases from the furnace are passed through the dryer to economize the oper-

*Abstract of article in the Sibley "Journal of Engineering," for December, 1913. See the following articles on this subject in "Engineering News:" "A New Method of Burning Powdered Fuel," March 14, 1901; "Powdered Fuel for Boiler Furnace at the Alpha Cement Co.'s Works, Alpha, N. J.," June 20, 1901, "A New System for Burning Powdered Coal," Dec. 25, 1902.

†Professor of Experimental Engineering, Sibley College.

ation. The cost of the drying and pulverizing operations in the large cement plants will run between 30 and 75 cents per ton of coal.

In addition to the drying and pulverizing machinery, there must be transmission machinery for handling the coal both before and after it is pulverized, and there must also be the machinery for feeding the fuel into the furnace. Pulverized coal in suspension is nearly as explosive as gunpowder; consequently, when in the pulverized state it must be handled very carefully. Numerous accidents which have resulted in extensive loss of life and property in the cement plants bear abundant evidence of the dangers attending the use of pulverized coal as a fuel. Of late years, extensive accidents have been prevented by carefully adhering to the principle of preventing sufficient air from entering the pulverized coal to suspend it, until it is actually at the point of delivery to the furnace. In the coal burning plants now erected, from the time the coal is pulverized up to the time of its delivery in the furnace, it is handled in closed conveyors and elevators from which air is excluded as much as possible. The pulverized coal will burn slowly when in a state of repose; consequently there is little or no danger of explosions provided it is not in a condition of suspension in the air.

In the cement industry the coal dust is delivered into the furnace almost universally by an air blast which in some of the mills is of high pressure and in other mills of low pressure. The air blast provides only a small portion of the air required for combustion, beirg sufficient only to convey the powdered fuel into the furnace.

In the portland cement industry the burning of pulverized coal has resulted in a great improvement in the art due to higher efficiency of combustion than had been found possible with oil and also to the lowering of the cost of production due to the employment of a cheap fuel in place of a high priced one.

The cement kiln is especially favorable to the burning of pulverized coal because the furnace is very long and an opportunity is presented of burning the fuel in suspension. In the cement industry the air supply is usually maintained at just about the theoretical amount required for combustion, so that maximum temperatures are obtained. This is favorable for high efficiency. It is, however, extremely unfavorable for the maintaining of fire brick linings. Experience in the portland cement art has demonstrated that no lining has yet been found which is capable of withstanding the high temperatures and the erosion effect due to the flame produced by the burning of pulverized fuel.

For the past two years, pulverized coal has been tried in numerous metallurgical processes with a considerable degree of success. It seems probable that the pulverized coal in many metallurgical furnaces will be highly successful and will be an excellent substitute for oil and producer gas.

W. G. Kranz, Superintendent of the Steel Testing Works at Sharon, Penn., has been successfully using pulverized coal as fuel in open hearth furnaces for about a year, and reports excellent results.

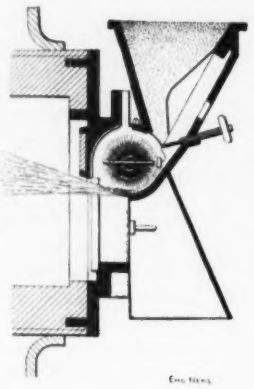
A paper on the subject of the use of pulverized coal for metallurgical furnaces was presented to the October meeting of the American Institute of Mining Engineers, by H. G. Barnhurst, and serves to show the interest in this matter at the present time.

In metallurgical furnaces where the form is such that the fuel can be burned in suspension, the chances for high efficiency are excellent, and if other conditions are not adverse, powdered coal can probably be used with excellent success.

The usual furnace underneath a steam boiler is not of a form well adapted to burn pulverized coal in suspension and the results from a commercial standpoint, of numerous trials, have not developed any commercially successful apparatus.

In addition to the early boiler tests with pulverized coal, to which I referred at the beginning of this article, I have known of numerous other tests. The most extensive test, of which I know, of apparatus designed to supply pulverized fuel for boiler furnaces was made under the direction of Wiltse F. Wolfe, in 1904-1906. These trials were made with a full knowledge of all the difficulties which related to the burning of pulverized coal under a boiler. The experiments were financed by a large manufacturer of pulverizers, and a large amount of money was expended in developing a burner and pulverized coal feeder for this purpose.

The general form of the pulverized coal feeding apparatus which was employed in the tests made by Mr. Wolfe, is shown in the diagram. In this apparatus the coal dust was supplied to an air-tight bin. The lower portion of the bin was supplied with valves which could be opened or closed by a handwheel and was arranged in proximity to a rapidly revolving brush of a cylindrical form. In operation, the coal dust discharged from the coal bin, was projected into the fire by the rotation of the brush; the arrangement being as favorable as could be de[illegible] to produce combustion [illegible] coal particles while in s[illegible]sion.



Mr. Wolfe made [illegible]us tests of this pulverized [illegible] apparatus under boilers [illegible] the Lehigh Valley region [illegible] practically every case t[illegible] efficiencies which he obt[illegible] were high and much b[illegible] than could be obtained by hand firing. So far as could be judged from the tests, the apparatus should have been a commercial success. I regret to say, however, that in not a single instance were any of the installations tried out by Mr. Wolfe permanently retained.

It was proposed about 1906 to employ pulverized fuel on locomotives, and several trials were made of apparatus for delivering pulverized fuel to a locomotive boiler furnace. Such apparatus was reported as showing excellent results but for some reasons it never attained any extensive use.

E. E. Walker and E. J. Snow made a standard test of a tubular boiler containing 1377 sq.ft. of heating surface set above the powdered coal burning furnace, with steam maintained at about 78 lb. boiler pressure, for a period of 10 hours. The fuel employed was Pittsburgh bituminous coal ground to pass a 30 mesh sieve and introduced with air at 4.45 ounces of pressure. The boiler was rated at 100 hp. and developed during the test 129.8 hp. The water actually evaporated per pound of coal from feed water at 136° was 8.7 lb. The equivalent evaporation per pound of combustible from and at 212° was 10.6 lb. The efficiency of boiler and furnace was 72.05%.

Messrs. Walker and Snow estimate from the figures given them the cost of grinding the coal and of delivering the same into the boiler as 24.76 cents per ton. It will be noted that the figures given are very much less than those given by myself as costs in the cement region. However, the coal for these tests was ground very coarsely, it was probably not dried at all, and the boiler efficiency obtained from its use was not remarkably high.

CONCLUSIONS

My opinion, based on the results of numerous trials, is unfavorable, at least under present conditions, to the burning of pulverized coal in boiler furnaces. Before a system of pulverized coal burning can succeed under a boiler furnace, such a change in form will have to be made as to permit the coal to be burned in suspension. I do not know of any boiler furnace which in its present form is adapted to burn pulverized coal in suspension. I also doubt very much whether the cost of properly pulverizing the coal would be warranted by any improvement in efficiency which could be obtained above the efficiencies now secured with stokers.

Another serious objection which will prevent the installation of powdered coal apparatus is the cost of the installation. The cost of a complete pulverizing plant capable of grinding and feeding 100 tons of coal per day would probably amount to between $15,000 and $20,000, which is considerably more than the expense of installing stokers of the same capacity.

It has been urged that pulverized coal can be burned under boiler furnaces without smoke. This I believe to be true. It is also true that bituminous coal of practically any grade can be burned in the best stoker installation without smoke, so I doubt if there would be much gain from the standpoint of smokelessnes through the use of pulverized coal.

⁂

The Operations of the United States Lighthouse Service were being conducted by 5536 persons on June 30, 1913, according to the latest annual report of the Service. This number includes a technical force of 86, clerical force of 146, and 5304 employees connected with depots, lighthouses and vessels. Of the 13,434 aids to navigation in use at the close of the year, 4379 were lights of all classes. During the year 1912-13, flashing lights were installed in the place of fixed lights at 26 stations; incandescent oil-vapor lights were substituted for oil wick lamps at 73 stations; acetylene lights were substituted for oil lights at 30 stations. The appropriations for the maintenance of the Service for the fiscal year 1914 are $5,071,930. In addition there are appropriations amounting to $722,600 for special work, such as new lighthouses and vessels.

The Use of Pulverized Coal as Fuel*

By W. S. Quigley†

Fuel is one of the most important factors in the cost of manufacturing. The importance of looking about for a method of using coal more economically than is possible with producer gas installations, was given a fresh impetus by the sudden rise in the price of fuel oil during the summer of 1912.

The supply of natural gas is decreasing, the demand for it for domestic use at better prices practically prohibits its use for industrial purposes.

Only heavy and inferior crude oils are available as fuel and improved methods of distillation render the supply of residual or fuel oil uncertain.

In addition to all these reasons, legislation prohibiting the smoke nuisance is becoming more general and the old plea or excuse that smoke cannot be done away with no longer exists, as powdered coal properly prepared and burned entirely eliminates it.

Powdered coal as a fuel is not new, the advantages of this method of firing having been fully recognized in the early fifties. It was, however, not a simple matter to burn powdered coal successfully as the enormous sums expended in experimenting have proven. The credit for the first really successful system of burning powdered coal in metallurgical furnaces, belongs to John V. Culliney, superintendent of the American Iron and Steel Co., who persevered and gradually worked out the underlying principles, and perfected a fuel controlling device which turned failure into success. From a small beginning nearly ten years ago, today he is operating over 77 furnaces in one of two plants operated by his company with chambers ranging from 24x30 in. up to 7x16 ft. burning over 150 tons of powdered coal per day.

My own company has installed plants capable of handling over 240 tons per day and are now installing plants capable of milling, distributing and burning over 740 tons per day in metallurgical furnaces for the following uses: Puddling, busheling, reheating, continuous billet heating, pipe welding, openhearth, case-hardening and annealing, plate heating drop forging, miscellaneous smithing, etc.

For best results powdered coal must be dry and fine. "Dry" means not over one-half of one per cent. of moisture (and I might here state that in addition to the advantages in burning, considerably less power is required to properly pulverize dry coal); and "fine" means that 93 to 95% should pass a 100-mesh sieve or 80 to 85% a 200-mesh sieve. It is obvious that the finer the coal the faster it burns.

With finely powdered coal the volatile gases ignite the instant the fuel enters the combustion chamber and the fixed carbon is consumed while in suspension, the temperature being very high. The resultant flame to a casual observer resembles one from either oil or gas and can be varied by the operator by adding more or less air or fuel as desired, at will by simply opening or closing valves governing the supply. The fire is under absolute control, not dependent upon stack draft or atmospheric conditions, and the entire inflammable portion of the coal is converted into heat without any loss whatever.

A coal milling building should be located at a place convenient to supply, from which the coal can be delivered to a crusher and reduced to the size required for pulverizing. From the crusher it must be elevated to a crushed-coal storage bin, from storage to dryer, elevated from dryer to dried-coal bin, from dried-coal bin to pulverizer, elevated to pulverized-coal bin, and thence to the distributing conveyers which supply the individual hoppers located near the furnaces from which the coal must be fed to the burners steadily under absolute control.

The controller or device which regulates the coal fed to the burners is to the powdered-coal furnace what the carburetor is to the gasoline engine; it must be flexible, as it determines the amount of coal which can be delivered or supplied to the burner. The controller is fastened to the bottom of a specially designed hopper or bin and consists of two screws, the upper propelling the coal forward to a point where it falls in a steady stream past the opening through which it is forced to the burner by a jet of low-pressure air, the excess coal falling to the lower screw of greater pitch, which returns the overflow back to the base of the hopper. This construction makes it impossible to jam, is practically fool-proof and permits any portion of the falling stream, up to the capacity of the upper screw, to be used at the will of the operator by simply turning on more or less of the air—called "controller air," this being less than one-seventh of the air required for combustion. A separate supply of air for combustion of a much lower pressure is introduced at the burner. The controller screws are operated by either chain drive or are directly connected to variable- or constant-speed motors, as conditions may require.

The current of "controller air" serves a double purpose. It not only forces the coal to the burner, but in picking up the coal it is mixed with it, so that upon entering the burner it expands into a well divided cloud, mixes readily with the combustion air and bursts into a clean flame, the length of which can be changed by adjusting the burner and varying the proportions of the furnaces to suit conditions. The volatile content of the coal also has a material effect upon the length and nature of the flame.

The fires are usually started by placing oily waste, or wood, in front of the burner, much the same as starting oil or gas fires, although on small furnaces where oil systems are already installed it is very convenient to use oil for heating the furnace ten or fifteen minutes before the coal is turned on.

In a three-door forge furnace having a chamber about 6 ft., wide by 18 ft. long, used for heating engine frames, etc., in the hammer shop of the American Locomotive Co., the fuel consumption hand fired with bituminous coal was 650 lb. per hour. With powdered coal it consumes but 350 lb. per hour and heats 20 per cent. faster. This amount will be reduced as the heaters become more familiar with the new fuel and realize that the smoky flame they were accustomed to so many years is not necessary. In addition, the special grade of blacksmith coal formerly used costs about 35c. more per ton than the coal now burned.

A report from the Lima Locomotive Works shows that a large furnace for supplying a 6000-lb. hammer, having a chamber 7 ft. 2 in. by 15 ft. 3 in. started cold at 8.15 a.m., reached a temperature of 2200° F. at 9:15, and 2500° F. at 9:45 a.m., which compares favorably with oil or gas practice. The coal used is bituminous run of mine with 34.70% volatile, a heating value of 14,000 B.t.u. per lb., and costs $2.25 delivered at Lima. Allowing 50 cents per ton for cost of pulverizing and distributing, which is a fair average, they get 31,360,000 B.t.u. for $2.75, or 114,036 B.t.u. for one cent, as against 27,282 B.t.u. for one cent with oil, the present cost being 4⅞ cents per gallon and no possibility of making a contract at that price.

Allowing 80% efficiency and 50 cents per ton for the cost of gasifying a ton of coal (both of which figures are in the gas-producer's favor), average practice considered, the comparison between oil, producer gas and powdered coal based on the cost of fuel in Lima, Ohio, would be:

Fuel oil	27,282 B.t.u. for one cent
Producer gas	91,228 B.t.u. for one cent
Powdered coal	114,036 B.t.u. for one cent

The cost of operating a powdered-coal plant having a capacity of 5 tons per hour or 50 tons per day is approximately as follows:

10 hour turn.		
100 hp. @ 1 cent per hp.-hr.	$10.00	
1 man @ $2.00 per day 1 man @ $3.00 per day	5.00	
1000 lb. of coal based on 5 to 8% moisture	1.00	
Waste and repairs	3.00	
	$19.00	
50 tons milled		$0.38 per ton
Conveying to furnaces:		
1 man	$2.50	
Power, 15 hp. @ 1 cent	1.50	
	$4.00	
For 50 tons		$0.08 per ton
Total cost of milling and conveying		$0.46 per ton

The average cost of gasifying one ton of coal, based on the average cost of four large concerns operating a number of plants located throughout the country, is 59.25 cents.

I believe I am justified in advocating the best and strongest designed machinery, well ventilated drying and milling plants separate from the main building, the handling of the coal in dust-tight covered screw conveyors, automatic stops on conveyor lines to prevent jamming when bins are full. Powdered coal should never be distributed with fans or mixed with a sufficient amount of air to support combustion or to form an explosive mixture.

In considering new installations the specifications for furnaces should therefore be so drawn that when constructed they may burn powdered coal as well as oil or gas fuel.

*From a paper read at the Annual Meeting of the American Foundrymen's Association.

†Quigley Furnace & Foundry Co., 26 Cortlandt St., New York City.

The Design of Storm Sewers

By John G. Schmidt*

One of the most important of the factors that enter into the design of a sewerage system is the amount of stormwater to be cared for. This depends upon the following: (1) the intensity of the rainfall; (2) the perviousness of the soil; (3) the slope of the ground and the provisions made for carrying the water to the point in question; (4) the area tributary, and (5) the shape of the area.

The most general method of computing the storm flow is by the use of empirical formulas which have been reduced at different times and by different engineers, but all of them have proved more or less unsatisfactory because the coefficients used are not universally applicable and because they leave out of the consideration some very important elements, namely, the shape of the drainage area, and the time required for the water in the sewers above to reach the point under consideration.

Were the coefficients, after being determined by experiment, used by the same individual on similar territory, the results would unquestionably be very accurate; but the coefficients are determined by one [illegible]er while later on another, whose knowledge of the [illegible]nal conditions is extremely limited, applies them [illegible]er territory.

As stated above, the amount of water to [illegible]ared for by a sewer depends upon the rate of rainfal[illegible] the duration of the storm, both of which are ver[illegible]certain. This can best be ascertained by plotting t[illegible]aximum storms recorded in the past on coördinate pa[illegible] and then drawing a curve high enough so that the s[illegible]rs which lie above this curve would not occur more freq[illegible]tly than once in five years.

High rates are usually for very short peri[illegible] but are apt to be much more troublesome than storms of a more moderate rate which last for a longer period of time and which yield a greater volume of water. Owing to the fact that the intensity is usually very high during the first part of a storm most of the empirical formulas will not give satisfactory results in the design of sewerage systems where the drainage areas tributary to the sewer are small, as is usually the case in built-up portions of a city. It is clear that were the rate in the use of the empirical formulas taken high enough to give good results for small areas it would be very excessive for large areas.

*Assistant Engineer, Division of Sewerage, Cincinnati, Ohio.

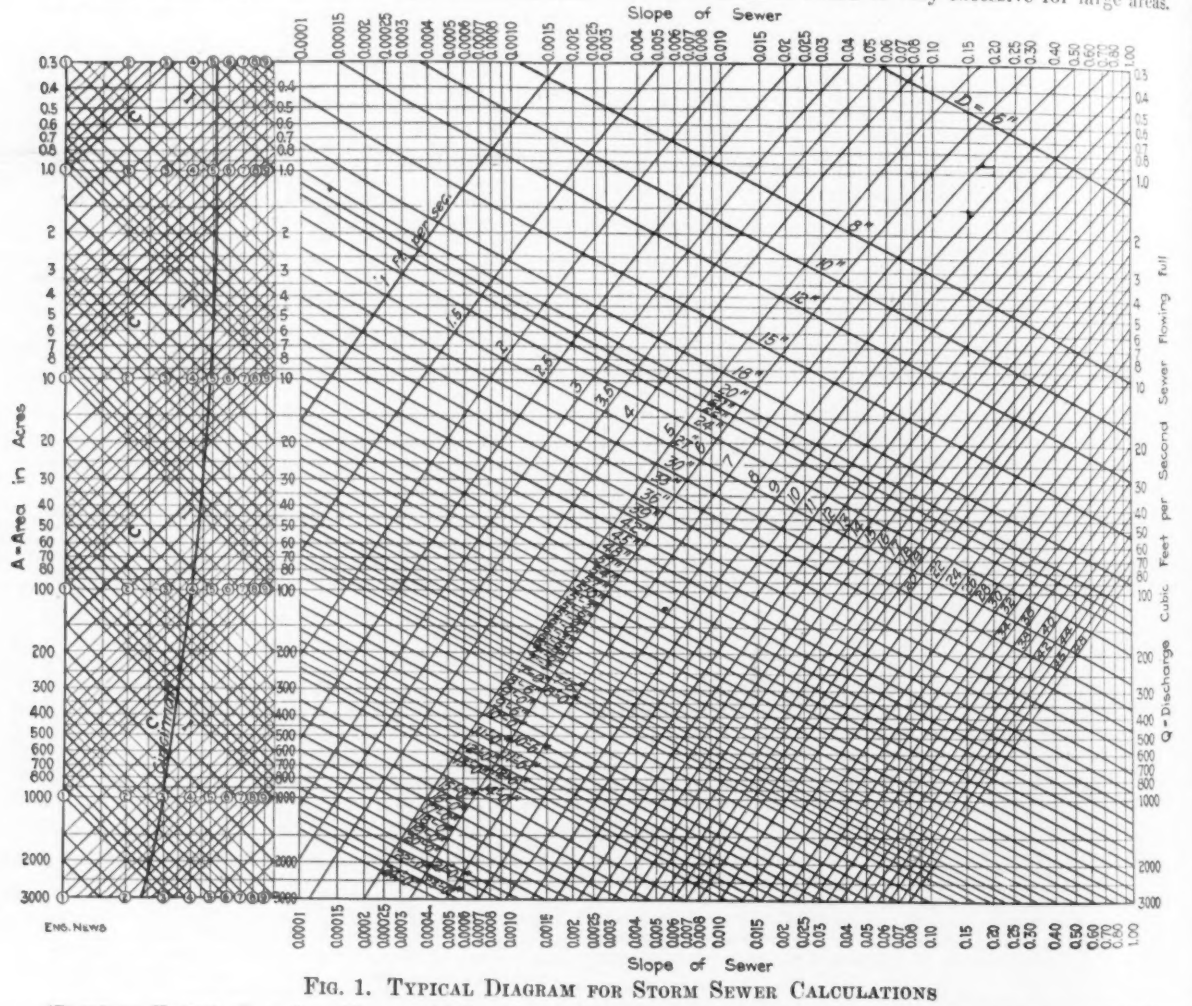


FIG. 1. TYPICAL DIAGRAM FOR STORM SEWER CALCULATIONS

(Based on Kutter's formula, with n = 0.015. Q = AIC, where Q = Discharge; A = Area in acres; C = Coefficient of Imperviousness. I = Intensity of Rainfall. For Cincinnati, $I = 16 \div \sqrt{T}$, where T = Time of concentration in minutes. In using the diagram make multiplication in order of formula, Q = AIC.)

The rational method of computing stormwater runoff is to [illegible] the intensity of the rainfall upon the time required for concentration of the water. For use in connection with this method of computation the writer has prepared the accompanying diagram (Fig. 1), which gives the capacity of sewers at different slopes and solves by the formula, $Q = A\,I\,C$, where Q = the [illegible] of water discharged in cubic feet per second, A = area of the drainage district in acres, I = the [illegible] of the rainfall, and C = the coefficient of imperviousness.

Observations in the past have convinced the writer that the relation existing between the intensity of the rainfall and the acreage, in improved city districts having approximately the same slope, can for all practical purposes be considered constant. This being true, the intensities previously calculated were plotted on coördinate paper (Fig. 2), the intensities as ordinates and the acreage of the drainage areas as abscissas, using one sheet for each of the following ranges of slope (feet per thousand): 1 to 10, 10 to 100, and 100 to 1000. A curve was then drawn through the greatest number of points and, by the method of least squares, their equations calculated.

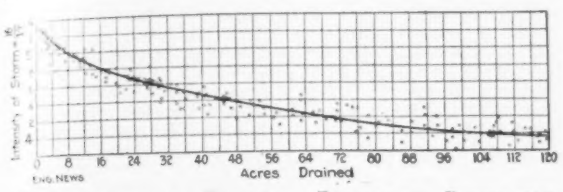


FIG. 2. AVERAGE RAINFALL INTENSITY CURVE FOR BUILT-UP PORTIONS OF CINCINNATI, OHIO, HAVING SLOPES OF 1 TO 10 FT.

(Base = $I = 16 \div \sqrt{T}$, where T = Time of concentration in minutes.)

Since the character of the ground, that is, its porosity or perviousness, has no effect upon the value of I, it is evident that once the relation of these curves to one another is established for the different slopes they can be adjusted to fit any rainfall intensity curve that might be adopted for other localities.

Examining the diagram (Fig. 1), it may be seen that the vertical lines are numbered from 1 to 10. These lines represent both the intensity (from 1 to 10) and the coefficient of imperviousness (from 0.1 to 1.0).

After measuring the drainage area with a planimeter, find the corresponding number of acres on the diagram and follow downward parallel with the line marked I to the proper intensity curve for that district (or in the event that the diagram is used without the intensity curves, to the vertical line representing the intensity), then move either to the right or left, parallel with the horizontal lines, to the proper coefficient of imperviousness (which must be determined in the same manner as though used in an empirical formula), then upward to the right parallel with the line marked C to the right of the diagram, where the discharge in cubic feet per second is given. Producing this point parallel with the horizontal lines to the estimated slope for the sewer, we have the size of the circular sewer necessary and the velocity of the flow in feet per second.

That the use of a variable rate of rainfall based on the time required for concentration is the logical method cannot be disputed, but, of course, the curve which is plotted on the diagram (which is the one for the flat sections of Cincinnati) will not be good for flat territory in other climates, owing to its dependence upon the rate of rainfall provided for in this city.

Each engineer must calculate the curves based on the area of the drainage district for his immediate locality, from the equation of rainfall intensity based on the duration of the storms or by actually measuring the runoff from a known area.

A Concrete Road at La Salle, Ill.*

BY A. H. HUNTER†

The Bottom Road at La Salle, Ill., has 75% of its length subjected to the ravages of the Illinois River in flood time; the remaining 25% is on a bluff and runs under the C., B. & Q. R.R. viaduct, up a 6% grade over the Illinois & Michigan Canal, and up another grade of 5.5% to the bridge over the Rock Island R.R. The river-bottom road consisted of an old water-bound macadam surface not more than 22 ft. wide, with steep slopes on either side extending to the bottom land some 10 to 12 ft. below. The other part, with shale and cinder surface, was restricted in width by the viaduct, and on the 6% grade it was only 18 ft. wide. Even then the toe of the side slope extended into the dooryards of adjacent property. Traffic consists of a large number of heavy trucks, a fair number of pleasure vehicles and numerous foot passengers.

The Illinois Highway Commission prepared plans for a 20-ft. concrete roadway having a thickness of 6 in. at the sides and 7 in. in the middle, shaped to a crown of 3¾ in. The road was built by day labor (except hauling, which was contracted) under the direct supervision of the Commission, with the writer as resident engineer in charge. The Commission furnished (free of charge) a 10-ton road roller and a concrete mixer, with an operator for each. The old macadam surface was loosened with a scarifier drawn by a 10-ton roller, the loose stone being then shaped to the crown of subgrade and thoroughly rolled. An abundance of stone dust remained on top, so a thorough wetting with water from the pipe line and an occasional trip of the roller prepared a sub-base, which gave an excellent foundation for the concrete and furnished a smooth surface for the shoveling of the gravel. Drainage for the foundation was provided by longitudinal ditches 8 in. wide and 6 in. deep under the outer edge of the concrete. At the end of the expansion joints a lateral drain, consisting of a trench filled with gravel, led to the riprap wall of the fill.

The aggregate consisted of clean, washed gravel, screened to sizes ranging from ⅜ to 1¼ in., and pure sand. The gravel was composed of granite pebbles in well graded sizes, with no loam, clay or disintegrated material. The sand was sharp and clean but rather fine. On the rolled subgrade, the loads of gravel and sand were dumped in rows. The quantity of sand and gravel per lineal foot of road was computed, and the wagons were measured and loads spaced accordingly. An effort was made to have all loads the same size, as this simplified matters for the man who dumped, and relieved the engineer of the incessant checking of quantities. To allow for waste and variation in thickness, 10% excess of material was provided. This proved sufficient, as there was not an excess or deficiency of more than 10 cu.yd. of sand and gravel in the whole road. All the cement (3200 bbl.) was donated by two cement companies.

As a large amount of water is required, both for mixing the concrete and for the proper curing of the finished road, it is the practice of the Illinois Highway Commission to construct pipe lines to which water may be furnished by city pressure or by a pressure pump operated by a gasoline engine. At La Salle, connection was made to the city water system and a 1¼-in. pipe line with T's every 300 ft. was laid along the road. With 150 ft. of hose connection attached to the mixer, it was possible to secure water at all points, although at the extreme end of the line the pressure was not sufficient to sprinkle the finished road work while the mixer was running.

*Abstract of a paper read before the Illinois Society of Engineers and Surveyors, January, 1914.

†Division Engineer of the Illinois State Highway Commission, Springfield, Ill.

A self-moving batch mixer was used, having a low hopper in front into which sand and gravel were shoveled direct from the road. Two sacks of cement were used for the batch. The concrete was deposited in place by means of a 20-ft. horizontal rotating boom on which operated a traveling dump bucket. This equipment made it possible to deposit the concrete on any spot of the wide base. The work averaged 450 sq.yd. per 8-hr. day. The concrete was struck off to crown and grade with a steel-shod template cut to the crown of the roadway.

Expansion was taken care of by means of ⅜-in. asphalt joints placed 50 ft. apart at an angle of 60° with the center line of the road. The edges of these joints were protected by Baker plates, cut to the crown of the road, having their edges flush with the surface. The edge of the concrete was retained by wood forms consisting of pine pieces 2x6 in., 16 ft. long, resting on edge, held to alignment by ⅝-in. iron pins 18 in. long. It was found difficult to butt the boards together perfectly, so the more imperfect form pieces were cut in 2-ft. lengths and used for splices, being nailed to the outside of the forms. This gave good results, especially on curves, where it was possible to align arcs of circles almost perfectly.

The mixture used was 1:2:3½, by volume. A box containing 0.95 cu.ft. was constructed and for each sack of cement placed in the hopper of the batch mixer, two boxes of sand and 3½ boxes of stone were added. The shovels of sand and stone necessary to secure the respective amounts of material were counted and this number used for each batch. When new shovelers were placed on the gang, the box was used to check the amount. The stone determined in this manner varied but slightly, but the sand had to be changed frequently. On a dry day the amount of sand on a shovel would be smaller than usual, while on a damp, rainy day, the amount would be considerably greater. The actual amount of cement in the mix was checked every 50 ft. of road by counting the bags and computing the number of barrels necessary for the length of road.

A concrete road surface to give good and lasting results must be properly cured, so that the surface coat will be tough and resist the impact of traffic. This end is usually attained by a covering of canvas while the cement is setting and by covering with earth to the depth of 1 to 1½ in. In both cases the cover is kept moist by sprinkling. No earth was obtainable as the lower edge of the fill wos swampy, so straw was used, and proved very efficient in retaining moisture. The sprinkling was continued for a period of ten days after the placing of the concrete.

The actual cost of the work was obtained by adding the daily expenditures, the cost of hauling and the market price valuation of the donated materials, inclusive of freight and all incidental items. To this were added the salaries of the resident engineer and the two roller operators. In all 10,663 sq.yd. of surface had been improved at a cost of $13,632. The common labor used was foreign and received 35c. per hour, and teams received 62½c. per hour. The itemized cost per square yard for labor and supplies is as follows:

Superintendence	$0.023
Excavation, shaping road bed and trimming side roads.	0.158
Hauling sand and stone	0.169
Mixing and placing concrete, setting forms and filling joints	0.133
Watchman and miscellaneous labor	0.116
Sand and stone, f.o.b. siding, including demurrage	0.314
Cement, f.o.b. siding, including demurrage	0.310
Expansion joints, f.o.b. siding, including demurrage	0.028
Coal and oil for mixer and miscellaneous supplies	0.021
Forms and other lumber	0.008
Total	$1.279

SIDEWALK, FENCE AND LIGHTING—The plan included a 3-ft. concrete walk on the east side, but this will be built later.

The guard fence was to be of reinforced-concrete posts and two lines of 2-in. pipe rail. Experiments on concrete fences were conducted by the Marquette Cement Mfg. Co. The accepted design consisted of a 6x6-in. concrete post extending about 3½ ft. above ground, reinforced by a ⅜-in. rod near each corner. Provisions for panels were made by leaving slots through the center of the posts. The two concrete panels were 2x6½ in., reinforced by two small rods near their edges, while a 1x1x⅛-in. angle was placed in the center to prevent lateral bending. In erecting the fence, the posts were placed 7 ft. c. to c., and the concrete rails were slipped into the slots. This method of erection was quite simple as no cement mortar or grout was necessary. Considerable care had to be used in aligning and setting the posts to grade or the appearance was unsightly.

A local utility company which secured the privilege of running a transmission line offered to construct the poles with a special arm from which a light fixture could be suspended, and this scheme was adopted. Conduits [illegible] placed under the concrete, 120 ft. apart, for connecti[illegible] or additional lights which will be provided on compl[illegible] of the sidewalk.

How the National Engin[illegible]ring Societies Could Help [illegible]e Profession*

By Edward E. Wall†

Is it possible for the National Engineering S[illegible]eties to educate the public to an understanding of the qu[illegible]fications of a real engineer? Can the people be taught [illegible] see the value of the services of competent engineers, as co[illegible]pared to pretenders? Life is too short for us to wait until sad experiences teach the majority of mankind that the constructive work of the world should be entrusted only to competent hands. It is my belief that we should furnish correct information to the public, at least so far as to name men that are known to be able in their respective lines, if no more.

There are now, and have been in operation for years, organizations supported by various manufacturing interests for the sole purpose of educating people to see the value and demand the use of various manufactured materials, for example, brick, sewer pipe, reinforced concrete, cement pipe, lime products, paving materials, etc. This apparently benefits the manufacturers, or the scheme would be abandoned.

Why, then, should not the National Engineering Societies maintain a Publicity Bureau for the distribution of the proper literature for the advancement of the profession? Every week technical journals publish a long list of engineering work about to be let, as well as projects proposed, giving the place and a brief account of the character of the work. It would be easy for a Publicity Bureau to get this advance information in time to do some missionary work in each locality, by distributing readable literature applicable to the case in hand emphasizing the value and necessity of employing capable engineers, furnishing a list of competent men with their records and holding up a few horrible examples of other communities that had suffered through the employment of persons not qualified to do such work.

The Bureau would not undertake to say that such-and-such a one was incompetent, but would give names of some that were competent. Objection may be made that the list might omit engineers who were fully competent and who might live and practice in the territory where the work was contemplated. This could only happen at first before the Bureau completed its lists.

The Bureau at the same time should use the local press to reach the citizens of each community. Why not go further, and through employed and capable press agents reitterate and impress upon the public mind, through the daily press the importance of the engineer's work in construction?

*From a paper read before the Engineers Club of St. Louis.

†Water Commissioner, St. Louis, Mo.

Completion of the Hindia Barrage, Mesopotamia—The new barrage on the Hindia branch of the Euphrates River was completed in the closing days of 1913. Its completion marks the first important step in the restoration of a vast tract of land, which thousands of years before the Christian era was at least a Garden of Eden, if not the original one, as Sir William Willcocks believes. In 1909 and 1910 extensive surveys of the so called delta of the Tigris and Euphrates Rivers were made under the direction of Sir William Willcocks, then consulting engineer to the Turkish Ministry of Public Works. In February, 1911, a contract was signed by the Turkish Government with the British firm of Sir John Jackson, Ltd., for the construction of a series of irrigation works, of which the new Hindia barrage is one. The barrage is constructed across a new channel, which is 2500 ft. long and 827.5 ft. wide, and is excavated parallel to the main stream of the Euphrates. The dam is approximately 834 ft. long, 25 ft. high, and is composed of a row of masonry piers with 36 openings between, 16.6 ft. in width. The piers are connected across the top by a series of masonry arches which support the operating machinery for the sluice-gates between the piers and carry a carriage way. At one end of the dam is a lock for navigation, 26.7 ft. wide and 23.4 ft. deep. The plans for the complete works for the reclamation of the great delta between the two rivers, the Tigris and the Euphrates, include a considerable number of other river regulation works with many miles of canals and drains between.

Editorials

The appointment of Henry Worth Thornton, General Superintendent of the Long Island R.R., to be General Manager of the largest railway system in the British Isles (the Great Eastern Ry.) is not only a signal honor to an American railway official, but is an international recognition of the efficacy of American methods of training and promoting railway civil engineers to executive positions. For like scores of other operating officers of the Pennsylvania R.R. system, including several of its Presidents, Mr. Thornton was educated as an engineer and began his railway experience in the engineering department. He had had seven years' experience in engineering work when his superior officers, because of his executive ability, transferred him to the operating department. Mr. Thornton's success is, therefore, a most notable example of the value of a technical education and an engineering training in fitting young men for executive positions not strictly in engineering work.

The extraordinary interest taken in Mr. Thornton's appointment by the popular press of England and the editorial comment it has drawn forth throw much light on the operating conditions on English railways; and it is certain Mr. Thornton will have many obstacles to overcome.

Evidently one of the first steps he must take is to open the door of opportunity, as it was once opened to him, to men who show ability, whether they are in the engineering or some other department. For it is the free-for-all competition and the absence of favoritism which has enabled such American railway companies as the Pennsylvania to develop such efficiency in operation.

Problems of the Chicago Sanitary District

The sewage-disposal problem of Chicago and vicinity is again to the front. A committee of the Chicago Real Estate Board, with John W. Alvord, consulting engineer of Chicago, as chairman, has recommended that "a board of the highest class of sanitary experts that can be obtained, either in this country or abroad," be engaged to study the problem. Mr. Alvord's committee calls attention to reports made several years ago in which it was urged that sewage-treatment works be installed to lessen the over-burden on the Chicago Drainage Canal. The committee states that although the government of the United States has never authorized the diversion from Lake Michigan of more than 4167 cu.ft. per sec. through the canal, there is evidence to show that 7000 to 8000 cu. ft. are being diverted. It adds that the Sanitary District is seeking authority, through the courts, to divert the 10,000 cu.ft. per sec. which was set as the maximum by the International Waterways Commission. Even though the District is successful in this suit, the committee states, 10,000 cu.ft. per sec. would be insufficient for the dilution of the sewage now discharged into the canal. notwithstanding which new territory to the north and south will be tributary to the canal when branches now under construction are completed; and territory, too, which the International Waterways Commission advised should be cared for by sewage-treatment works. The harbor and river improvement committee of the Chicago Real Estate Board has indorsed the conclusions of Mr. Alvord's committee and prepared a series of questions to be submitted to a possible board of three engineers. The Board itself has passed resolutions requesting the officials of the Sanitary District to coöperate in the proposed investigations.

Whether much progress is likely to result from another engineering investigation is an interesting question. Perhaps something of the kind is needed to clear the air or overcome inertia, but at this distance it looks as though the delays in meeting the Chicago sewage-disposal situation were not due so much to lack of engineering advice as to failure to follow that already in hand. In addition, it looks as though the affairs of the Sanitary District, as well as of that portion of the District comprising Chicago, are suffering from some of the evils incident to the 19 local governments which burden Chicago.* The unavoidable overlapping of functions under such conditions is liable to lead to confusion of issues and clashing of aims and methods, besides begetting rival political ambitions, with their trains of evils.

It seems to us that some of these governmental and political aspects of the Chicago sewage-disposal problem are in more need of investigation than the strictly engineering problems confronting the District. It may be, however, that each demands study.

Public Utilities and the Engineer

It is a notable illustration of the extent to which the relation between public-utility corporations and the public is assuming prominence in the engineer's work that this was the main theme of the speeches at the great banquet given by the New York Alumni of the Rensselaer Polytechnic Institute on Feb. 6, to prominent engineers of New York City, in celebration of the 90th birthday of that famous institution. The after-dinner speakers included Howard Elliot, President of the New Haven R.R., Samuel Insull, President of the Chicago Edison Co., and E. A. McCall, Chairman of the New York City Public-Utilities Commission. In the fine address of the Toastmaster, Nelson P. Lewis, Chief Engineer of the Board of Estimate, of New York City, the idea was emphasized that the public is turning toward the engineering profession as the main source in which to find com-

*See "The Nineteen Local Governments in Chicago," a report by the Chicago Bureau of Efficiency, December, 1913. It may be noted that the Sanitary District of Chicago has an area of 386 sq.miles, half within and half without the city limits of Chicago. The district is administered by nine trustees, elected at large. The President of the Board is elected specifically to that office. He appoints all employees and fixes their pay, subject to the approval of his fellow trustees, and without civil-service control.

petent and impartial arbitrators for the fair adjustment of these complex relations.

This Rensselaer banquet follows close upon the Stevens Institute conference in January, at which a large gathering of alumni was brought together especially to consider the public relations of the engineer.

When one considers that the number of engineers engaged in work for the various State Commissions in control of public utilities and the Interstate Commerce Commission reaches into the thousands, while the work that is done by these thousands closely affects the duties and responsibilities of many more, there is good reason for this general attention to the subject by engineers.

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A Higher Value Necessary for Brake Retardation in Railway Bridge Design

The longitudinal "traction" force, more properly *braking* force, to which railway bridges and viaducts are exposed, may reach a value as high as three-tenths the total train weight—so we learn from the Pennsylvania R.R. brake tests just reported.

Existing practice in providing strength to resist braking stresses is not well systematized, but, insofar as there is a uniform practice, bridge engineers use values of 0.2 to 0.25 as maximum rail friction of braked trains. These are by no means low figures, for they imply a retardation of 4 to 6 mi. per hr. per sec., which is far beyond the retardations of ordinary experience. But even if the higher friction-value of 0.3 be attained only on rare occasions, the designer is bound to provide for it, because the rare emergency loadings are always the dangerous loadings. It will not do to have a bridge sufficient for its service 364 days in the year, but too weak for the loading of the 365th day.

S. W. Dudley, Assistant Chief Engineer of the Westinghouse Air Brake Co., gave this month a very elaborate report of these new brake tests before the American Society of Mechanical Engineers. This report is much too extensive for our space; but we give a summary of the main results, elsewhere in this issue, and for most engineers this summary gives all the information needed. It will be seen from this abstract that the tests dealt, mainly, with new and highly improved brake mechanism, involving the use of two brake-shoes per wheel ("clasp brake"), higher average brake-cylinder pressures than used heretofore, and electric actuation of the brake-valves throughout the train. The effect of the latter feature is double, since it not only (by allowing higher brake pressures to be used) results in greater retardation, but applies full pressure more quickly. The latter effect is indeed the very reason why higher brake-pressures may be used without running the risk of dangerous shocks in the train. The total effect is to subject the track (hence a bridge) to a more severe braking stress, and to apply this stress more suddenly, which latter means that its effect is likely to be more severe.

It is probably true that the new maximum braking action will occur only sporadically (if at all) until the improved mechanism has come into common use on fast or heavy trains. This might be taken to mean that the lower values of brake-drag will be sufficient in bridge design for many years to come. But we do not believe this to be a safe estimate of the facts, for two reasons: First, it is probable that individual trains equipped with the improved brakes will operate over many railways soon, and the bridge designer should not rest in the faith that such a train may not happen to run over his railway. Second, it is not unlikely that the maximum value of brake-drag occurs from time to time even under present brake equipment, since the elements of variation in brake action are numerous and erratic (see Dudley's report); skidded wheels—a sign that the full rail-adhesion is called into play—occur even now under the heaviest trains.

We may note also that accidents to poorly braced trestles from brake-drag have been known to occur, and that damage to bridge floors, of a kind suggesting excessive longitudinal forces, has been reported more than once. Altogether, the prudent designer will find good warrant for making ample brake-stress allowance in bridge design.

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The Increasing Use of Powdered Coal

A multitude of inventors have labored over the problem of burning coal by reducing it to an impalpable powder and delivering it into a furnace by a blast of air. It is perfectly easy to burn coal successfully in this way under the conditions found in the experimental laboratory. Indeed we may go further and say that coal-dust burning apparatus was made and used probably a quarter of a century ago that seemed to be in many respects a practical success.

It is one thing, however, to make apparatus which will operate successfully and quite another thing to bring that apparatus into regular commercial use. The inventors who have spent time and money in perfecting dust-fuel burning appliances have almost without exception received no return whatever for their labors.

There is at present a great revival of interest in dust-fuel burning appliances. A new set of inventors and engineers are busily at work upon the problem with the same sanguine hopes of success that animated their predecessors of an earlier generation. It is worth while, therefore, to inquire in what direction commercial success may reasonably be expected for methods of burning powdered coal.

Elsewhere in this issue we publish two papers on the subject; one by Prof. R. C. Carpenter, whose intimate connection with the development of powdered-coal burning appliances in the cement industry is well known. The other is by a manufacturer who has been prominent in the recent development of the use of powdered coal in metallurgical furnaces.

Probably the best argument for the future success of powdered-coal burning systems is the success which has already been attained. As most of our readers know, nearly the entire volume of portland cement produced is burned in rotary kilns with powdered coal as a fuel. Here is an application of powdered coal that has been in use for a dozen years or more on an enormous scale; and while there were distressing accidents and difficulties in the early stages of the industry, the operation is now as regular, continuous and satisfactory as any other operation in connection with the production of cement.

The flame from a powdered-coal burner is so much like the flame from a burner using gas or oil that a novice

would not detect the difference. The increase in the price of fuel oil during the past two or three years has set many engineers at work upon the problem of substituting powdered fuel in place of oil fuel in metallurgical furnaces; and such powdered-fuel furnaces are now regularly working in a number of iron and steel manufacturing plants. So far as at present appears, a further large development in this field may reasonably be looked for. It is even claimed that the powdered-fuel burner may supersede the gas producer in many lines of metallurgical work.

When we come to steam boiler furnaces the difficulties in the commercial application of powdered-fuel burning are at once multiplied. It is not that there is any great difficulty in putting powdered fuel into a boiler furnace and burning it to raise steam; that can be done successfully, by the use of proper intelligence in the design of the apparatus. The difficulty lies in showing any great economy in the process over the ordinary method of burning coal.

In the latest large central-station power plants, for example, coal is fed by automatic stokers to the boiler furnaces and is burned with an efficiency which often exceeds 80%. There is little reason to expect that if the fuel were fired in the form of an impalpable powder any materially higher economy than this could be attained and on the other side of the account must be set the cost of the thorough drying and pulverizing, amounting to perhaps 50c. per ton, which is essential to success in the burning of powdered coal.

While it would not pay to use powdered coal in the very large steam plants, it would not pay either in the very small ones. In a small power plant the cost and complication involved in dust-fuel burning apparatus would make it quite out of the question under ordinary circumstances.

If dust fuel is to be burned for steam raising, therefore, it must be under circumstances which make its use for some reason especially advantageous as compared with ordinary methods of firing. A number of inventors are at work, for example, on the application of dust firing to locomotive boilers. It is even said that some of the large locomotive-building companies are taking an interest in the experiments. It is well known that under ordinary conditions of firing fuel in a locomotive firebox, a large percentage of the fuel is carried by the blast out of the stack unconsumed, and the losses in various directions are very heavy. Inventors working in this field, however, have to face the difficulties involved in carrying on each locomotive a complete coal-drying and pulverizing plant, which must work in all weathers and in all conditions with no better attention than can be given by the ordinary locomotive fireman.

Another place where dust firing may have a fighting chance for success is on shipboard. The mechanical stoker for marine boilers has not yet been made a commercial success. If dangers of explosion could be overcome, it might not be impracticable to dry and pulverize the coal and blow it into the furnaces as required. Here again, however, the commercial difficulties must be reckoned with. If the drying and pulverizing of the coal are to cost as much as 50c. per ton, the ship owner will have to be shown economies which more than offset this expense.

It may happen with this, like many other new departures in engineering, however, that uses will be found for it under special conditions which are not at first apparent. Like many another new device it may find a field of its own to occupy quite apart from that held by the older methods of working. It is quite within the possibilities, for example, that powdered-coal appliances may become extremely valuable in connection with the burning of fuels which are difficult to handle by ordinary methods. The lignite coals, for instance, of which enormous deposits exist in Dakota and other sections of the West, contain very high percentages of volatile matter and are difficult to burn successfully with ordinary methods. By reducing to the form of dust it is possible that their use might be enormously extended.

Again, there is a large amount of coal which shows a high percentage of combustible and is satisfactory in every way, except that the chemical constituents of its ash are such that it clinkers badly on the grate bars. Very recently it has been reported that tests of some of the Alaska coals under boilers in United States Naval vessels have shown that it is almost impossible of use because of the rapid formation of slag on the grate bars. It is possible, however, that a coal of this sort if pulverized might be burned successfully in boiler furnaces, with proper precautions against the deposit of dust and slag in the tubes or on the heating surface.

Similarly there are vast amounts of slack or fine coal produced by most bituminous mines which is marketable only at a low price and can be burned only with great difficulty and wastefulness in ordinary furnaces. By reducing this fine coal to powder, it should be possible to utilize it economically.

The New York State Highway Department: After Investigation, What?

For months now, ever since the political campaign of last fall, the newspapers have been filled with reports of the investigation of fraudulent work on the New York State highways. District Attorney Whitman, of New York City, and other prosecuting officials have been diligent in their search for those who have been responsible for blackmailing contractors, or who have conspired to defraud the State by poor work at high prices. Some have already been convicted and sentenced, and the net is being drawn tighter around others. Governor Glynn's special appointee, Jas. W. Osborne, is also conducting an investigation, and last week the Republican Assembly voted to undertake an investigation on its own account.

That this wholesale investigation is a necessary and salutary process, engineers who know of conditions inside the New York Highway Department during the past few years will generally agree. Unfortunately, in the hue and cry after victims, the innocent may at times have to suffer with the guilty. Men who were compelled to participate in a system that they detested may have to suffer penalties, in injury to reputation and standing and in more serious ways, greater than they deserve.

At present the public is inclined to over-estimate the fraud and loss in the State road work and to be deeply suspicious of everyone connected with it. There was fraud and graft in plenty, as everyone now knows; but probably the loss was almost as great from ignorance and incompetence as from outright fraud. Contractors built

bad roads not merely to make exorbitant profits, but because they did not understand how bad results their methods would produce. Their political pull enabled them to snap their fingers at the engineer; so why should they build the road the way his specification required? And not all the engineering work was above suspicion.

It is, as we have intimated, a necessary and salutary process to uncover these things and to punish the guilty where guilt can be fixed. The State will not get back the money wasted and stolen. That is irretrievably lost; but as a warning to others tempted to defraud the Government, the investigations and court proceedings are doubtless worth all they cost.

What we particularly wish to point out, however, is that all this work of chasing criminals is after all looking to the past rather than the future. The most valuable thing the State can obtain from investigating these highway frauds will be the knowledge how to proceed in expending its second fifty million dollars, in order that the experience with the first fifty million dollars may not be repeated.

And this question interests not alone New York, but every other State of the Union where State highway work is going on, as well as States where road work is carried on—and generally very badly carried on—by county authorities.

We do not now recall a single State which is attempting State work on highway improvement on any considerable scale, where more or less of public criticism and dissatisfaction does not exist. It may be in many cases unwarranted; but it is causing trouble and anxiety to those in charge of the work just the same.

That this dissatisfaction is bound to greatly retard the progress of road improvement can hardly be doubted. If New York State were to vote again today on the second fifty million dollar bond issue for State road work, the proposition would be overwhelmingly defeated. Pennsylvania's defeat of a $50,000,000 bond issue for roads last fall was largely due to the news of New York's unfortunate experience, as well as to widely published criticisms of its own highway department.

Unless the voters and taxpayers are satisfied that their money is to be honestly and efficiently spent, they will not vote funds for road improvement. Nor does the matter rest here. The only way to build roads economically and efficiently is under direction of honest and competent engineers. But such engineers will not work any longer than they can possibly help under such conditions as have prevailed in New York State. Competent road engineers are none too plentiful; but what inducement is there to an engineer to specialize in road work and take a position where a political change may at any moment cause his discharge or where a conspiracy may at any time be formed to make him a scapegoat for the crimes of others?

The question of organization, then, is the question which needs to be settled, and settled right, before the good-roads movement can make progress. Once settle that and all other questions will be easy of solution. When engineers can join a state engineering organization, with confidence that merit and not political pull will meet with reward, there will be plenty of competent engineers to take up road work. And with competent engineers in control, the questions of what types of road to build and how to build them most economically and efficiently will largely settle themselves.

It is of interest to record that Governor Gl[illegible] special highway investigator, Jas. W. Osborne, has [illegible]y gone on record that the first essential to honest hi[illegible] work is that it should be taken out of politics. W[illegible]ote as follows from a published interview with Mr. O[illegible]ne:

> **The highway system of the State of New Y[illegible]ust be taken out of politics once for all. Many million[illegible] dollars have been all but wasted through the alliance of [illegible]ractors and politicians. That alliance must be made im[illegible]ible before a single dollar of the second $50,000,000 is ex[illegible]ed.**
>
> **We already have disclosed the general types of [illegible]use and corruption; no matter how much further the in[illegible]tigation may go, the system will be the same, the meanin[illegible] of it the same. And the lesson will be the same.**
>
> **As long as the men at the top of the system, who control the selection of executive officers, the choice of r[illegible]es, the letting of contracts, and the work of construction and repair, are chosen for political reasons; as long as there remains a possibility of alliance between politicians and contractors doing work upon the highways, so long the work of highway construction and maintenance will be tainted with corruption and will manifest inefficiency.**
>
> **I shall recommend to Governor Glynn legislation to remove the entire highway system of the State from the field of party politics.**

This has a very familiar sound to engineers, for it is in substance what engineers have talked among themselves time out of mind. The engineering profession knows and has long known that political control of public works means invariably sacrifice of economy and efficiency and in too many cases graft on a large scale as well.

What has happened in the New York State Highway Department is no surprise to engineers. It was, in fact, predicted years ago in the columns of ENGINEERING NEWS, when Gov. Dix abolished the non-partisan State Highway Board established under the previous administration, and put the work under political control.

If New York and other States are indeed rendered wiser by experience, how will they go about selecting "the men at the top of the system"?

Gov. Dix announced his belief that the voters of the State should select the men to build their roads and he put that policy into effect with results that are now known to all. Nevertheless, many otherwise intelligent people still cling to the belief that if the voters will only nominate and elect all the candidates for every public office, the political millenium will arrive.

Fortunately, a wiser policy seems now to be gaining ground. The "Short Ballot" reform commends itself to the common sense of every voter who realizes the impossibility that he can exercise intelligent choice in the selection of more than one out of a dozen of the long list of candidates now put before him at every election. Appointment of minor State officials and of all State boards and commissions by the Governor instead of their selection by popular vote is now agreed by all those best qualified to judge to be the preferable method of filling such positions.

Here again, the results will depend more than anything else on what public opinion demands. If the public wants and demands loudly enough that a Governor should select for a State Highway Commission men of such prominence and good reputation that they can be trusted to conduct the work with an eye solely to the public interest, almost any Governor will heed this demand.

Experience has shown greater success with this plan of conducting engineering public works than with any other. In New York City the Rapid Transit Commission and its successor, the Public Utilities Commission, have expended many millions of dollars upon the greatest under-

ground railway system in the world; and no question has ever arisen as to the honesty and efficiency of the work.

Boston, too, has built its subway system under direction of a Commission appointed by the Governor; and the work is famous the world over as a piece of successful engineering. In fact, Massachusetts has for more than forty years pursued the same general plan in the conduct of all its public works; and its success in obtaining high-class work and freedom from graft are an object lesson to other States of the Union.

Of course, with this system, as with any other, success will depend ultimately on the men selected to administer it. No system of government or of organization is a panacea to cure corruption. If a Governor appoints a set of politicians to run the highway department, it will very probably be administered with political ends or worse in view.

But a good system can aid greatly by making good work easier. It is an advantage, for example, to have a continuing commission, with only one member's term of office expiring at a time, so that a change of politics in a State administration will not necessarily mean the upsetting of the entire organization. It is an advantage to have three or five men in control rather than a single commissioner. Their united reputation and authority will prevent baseless charges being made and circulated, where a single commissioner would be comparatively powerless to defend himself.

But it may be said, why appoint a highway commissioner at all? Why not have the Governor appoint a high-class engineer as head of the Highway Department with full authority over the entire work?

In answer to this it may be said that the plan is an excellent one as long as the engineer lasts; but in many States the "Black Horse Cavalry" would get the engineer's head as soon as a new Governor assumed office. Few engineers are strong enough in public reputation to make a successful defense against such attacks. It is easy enough to cook up charges enough against almost any engineer responsible for a great public work to deceive the public.

The great value of a Commission made up of three to five well known men of established reputation is that they can stand back of the engineer and the engineering organization. A Governor who would chop off an engineer's head without a qualm will be very slow to put out of office a set of men known throughout the State for public spirit and high business standing.

Such a commission as we are proposing should under no circumstances undertake executive work. It should correspond in function to the Board of Directors of a Corporation and should delegate all executive work to the Chief Engineer or other head which it selects, just as the directors of a corporation delegate all executive responsibility to the President.

The trouble with making the Commission an executive body and expecting it to do the detail work of preparing specifications, letting contracts, and supervising the organization is, first, that such a division of executive authority always means delay and loss of efficiency, and, second, that the kind of men we have proposed above are not fitted to and will not undertake such detail work.

That was the greatest defect with the non-partisan Highway Commission established in the Hughes administration. That Commission was an executive commission and its members had to be selected with that in view, and were not men who were widely known. Had the commission been made up of the sort of men above suggested, Governor Dix and his legislature would have at least hesitated to defy public opinion by legislating them out of office.

Letters to the Editor

Employment and Investment Combined: A Warning from a Victim

Sir—In your issue of Nov. 13, 1913, you published an editorial under the title, "Employment and Investment Combined: A Warning," cautioning engineers against a company that was advertising for high-class engineers, draftsmen, etc., to associate with them on a coöperative basis, which association required a cash investment in the stock of the concern.

Unfortunately, I did not connect your editorial with the advertisement of the ——— Co., and I invested with it. With the hope of warning engineers against similar operations, I believe the following statement of facts should be published, withholding nothing. I only ask you to withhold my name for the reason that I wish the memory of my connection with this company to die out as soon as possible. The statements made herewith, I will substantiate under oath to proper parties.

So far as I can discover, the incorporators have done nothing which would render them criminally liable—at least there is no written evidence of this. I answered one of the many advertisements and after some correspondence, met the President of the company and as the result of this conversation, signed a contract for two years' employment at a stated salary, and made a considerable cash investment.

I had previously looked up the rating of the company in Bradstreet and found them rated well with a good large percentage of the capital stock paid in. In my interview with the President, I was told that the company had contracts sufficient to run them several months; that business in sight warranted a highly successful future—in short, an extremely optimistic view of the company's condition. Soon after beginning work, or rather the attempt to begin work, I found the following conditions: not a single contract was in evidence—though there were many live prospects; that the "Paid in" capital stock was largely good will stock to the incorporators; and that the company was in arrears with operating expenses and salaries.

After some weeks time, I concluded I had—to use a slang expression—been stung; and I left the company. As to the present condition of the company, I know that at this writing attachments for labor claims have been made at the main office; the offices in the other cities have been abandoned or are, to all intents and purposes, dead; that some thirty, more or less, stockholders who entered in good faith, have scattered and have, or are looking for, other positions.

I am given to understand that the attempt is still being made to induce further investment with the company, which is the main reason I am writing you.

I am taking steps through one of the engineering societies to have my connections with the company investigated so that any stigma attaching to the incorporators will not furthur pursue me.

X. Y. Z.

Jan. 30, 1914.

[We omit the name of the company from the above letter because we especially desire so to present the lesson from experience which is above taught that it may be read and heeded by engineers everywhere.

Our note in our issue of Nov. 13, above referred to, was purposely so worded as to caution the engineer against investing his hard earned savings in *any* concern offering him employment until he had thoroughly satisfied himself that the investment was a safe and wise one, taking counsel, if possible, with some friend of sound business judgment and knowledge of the industry concerned.

Many times in the past quarter century have cases come to our knowledge where honest engineers have been beguiled into purchasing stock in some concern of doubtful reputation and uncertain future by the promise of a "permanent" position. We publish our correspondent's letter, therefore, in the hope that his dearly bought experience may teach a useful lesson, not merely to those who might be dazzled by the promises of the particular concern to which he refers, but to engineers everywhere who have similar bait laid before them.

It is of interest to note that since the above letter was received and put in type, further developments have taken place. On Feb. 4, the offices of the concern referred to by our correspondent were raided by the authorities, the books and records were confiscated and the concern's treasurer and general manager was arrested on the charge of having sold stock in the company without a permit from the State Banking Department, a violation of the State "Blue Sky" law. The President of the company was arrested on Feb. 7 and we are informed is also to be prosecuted for obtaining money under false pretenses. According to published statements by the authorities investigating the concern, some $30,000 worth of stock was sold to engineers and others who had been given positions with the company.—Ed.].

The Compensation of Engineers

Sir—Your editorial on "The Compensation of Engineers," in your issue of Jan. 22, seems to the writer to be to the point. There is no doubt that the table compiled by the committee of the American Society of Civil Engineers is correct in accordance with the data they had; but that it represents even approximately the compensation of engineering graduates of three or more years' experience is very doubtful.

The writer is acquainted with a good many men who think they are engineers and who have had [illegible] years of experience as such, some of whom belong in some capacity to the American Society of Civil Engineers, and he doubts that they earn on the average three-fifths of $4325 per year. It is true that his engineering friends and acquaintances are confined principally to [illegible] to the states of Louisiana and Texas, but he has met some from other portions of the United States and they usually had the same story to tell, which agreed very closely with the writer's observations.

The greatest number of civil engineers or of men employed as such, work for corporations or for the few other engineers who are in private practice, and their pay should be the index of the compensation of engineers instead of the comparatively few who in private practice or otherwise have succeeded in making money.

The writer would very much like to know the average pay of the subordinates of these 3636 engineers on whose compensation the table in question was based, and he is not interested in the whys or the wherefores of this pay.

According to the writer's observations, a young man of the caliber of most young engineers can begin as a locomotive fireman and in from three to five years time his pay will equal or exceed that of the division engineer, and in from five to seven years' time his pay will very likely exceed that of the first assistant engineer. You may ascribe this to any reason you like, but it is a fact.

Assoc. Am. Soc. C. E.

New Orleans, La., Feb. 7, 1914.

NOTES AND QUERIES

Francis Donaldson, Chief Engineer of the T. A. Gillespie Co., 50 Church St., New York City, was inadvertently stated to be "Engineer, Board of Water Supply, New York City," in a foot-note to an abstract of an article by Mr. Donaldson on "The Injection of Cement Grout into Water-Bearing Fissures," published on p. 321 of our issue of Feb. 5, 1914.

A Patent on the Autoclave Test for Cement

A patent on the autoclave* method of testing cement has been issued under date of Feb. 3, 1914, and No. 1,085,977 to H. J. Force, Chemist and Engineer of Tests, of the Delaware, Lackawanna & Western R.R. The application was filed Sept. 13, 1912. The specification is as follows:

Be it known that I, Howard J. Force, a citizen of the United States, residing at Scranton, in the county of Lackawanna and state of Pennsylvania, have invented a new and useful improvement in methods of treating portland and similar cements, of which the following is a specification.

In the methods of testing portland and similar cement for tensile strength heretofore practiced, the cement was made into briquets having a cross-section of 1 sq.in., then allowed to set for 24 hours in a moist closet, and then broken in a machine for testing tensile strength. Similar briquets have also been subjected to a boiling test before being broken, which test consisted in boiling the briquets under atmospheric pressure for the purpose of ascertaining whether or not the briquets would become cracked or disintegrated in boiling water. Cements which have successfully withstood these tests have, nevertheless, failed when made into concrete, for the reason that they contained a considerable percentage of

*See previous articles in "Engineering News," June 13, 1912, p. 1111, 1136; Jan. 23, 1913, p. 185; July 10, 1913, p. 83.

large or coarse granules which did not readily absorb water or become hydrated in mixing the cement with water preparatory to testing samples of the cement and which afterward, when the cement had been used for making concrete, had absorbed water and caused a swelling, disruption or disintegration of the concrete.

The object of this invention is to provide a test which will effectually show the character of the cement as to permanency or durability when made into concrete.

In practicing this invention briquets are made up of neat cement with a sufficient quantity of water to make a fairly plastic mass. These briquets are made in the usual brass molds having a cross-section of 1 sq.in. and are placed in a moist closet where they are kept for 24 hours. At the expiration of this time a number of these briquets, usually three, are broken in a testing machine, and another like number of the same briquets are boiled under pressure for about two hours. The pressure is preferably about 20 atmospheres, or 285 lb. per sq.in., which pressure is conveniently produced by placing the briquets in an autoclave or digester which contains water of about 70° F., then closing the autoclave and then raising the temperature of the water by means of a gas flame or other suitable source of heat. It takes usually about an hour to reach a pressure of 285 lb., and this pressure is maintained for about an hour. Upon the expiration of this time the flame is extinguished and the pressure is blown off, which usually takes about 20 minutes. The briquets are then taken from the water and if they have not been injured by the boiling they are placed in a moist closet for about half an hour. The briquets are then weighed and the gain or loss in weight is noted and the briquets are then broken in a testing machine.

It has been found that only cement which is sound in every way and suitable for producing a sound and lasting concrete will resist boiling under pressure successfully. Cements which will pass this test successfully are such which have been carefully manufactured by grinding the ingredients very finely, for instance so that 85% of the ground material will pass through a sieve of 200 mesh to the inch, then calcined or burned at a high temperature, for instance 2700° F., and then again ground to about the same fineness, or cements which are made of ingredients which have been thoroughly seasoned for several months after calcination. Inferior cements which are liable to produce unreliable concrete will crack or disintegrate when boiled under pressure, or show a decided loss in tensile strength. Practice has shown that a presure of 285 lb. per sq.in. is very effective for producing the conditions which will bring to light the character or quality of the cement under treatment, but this pressure may be varied as circumstances may require. The pressure should, however, exceed 50 lb. per sq.in. in order to produce the desired result within a reasonable period of time and the higher the pressure is kept the quicker the desired result is reached.

One of the advantages of this process is that the briquets will be in condition for testing after a treatment of a few hours' duration.

A satisfactory quality of cement will show a considerable increase of tensile strength after having been boiled under pressure as compared with the same cement which has not been so treated, the increase being 25%, or more, and an unsatisfactory quality of cement will crumble or disintegrate under the treatment herein described. The tensile strength of the cement treated under pressure should not be less than 400 lb. per sq.in. The gain in weight by the cement during the boiling under pressure should not exceed 1%.

The same test is also desirable for ascertaining the character of the cement with reference to expansion. For that purpose expansion bars are made of the cement mixed with watr in the usual way with a cross-section of about 1 sq.in. and a length of about 6 in. The bars are then placed in a moist closet, and at the expiration of 24 hours are carefully measured. They are then placed in the autoclave and boiled under pressure as above described, and at the end of that treatment are again measured. Cements which are constant in volume should not show expansion of over ½% when tested under the above described conditions. The pressures mentioned herein are measured from the atmospheric pressure as the zero.

I claim as my invention:

1. In the method of preparing solid bodies of portland or similar cement for testing the same the herein described treatment which consists in boiling such cement bodies under a pressure which exceeds 50 lb. per sq.in.

2. In the method of preparing solid bodies of portland or similar cement the herein described treatment which consists in boiling such cement bodies under a pressure approximating 285 lb. per sq.in.

Control of Patent Rights

We have received from Mr. Force the following statement in regard to the control of the rights under the patent:

At the present time several of the cement companies have made application for licenses so as to be in a position to manufacture, and guarantee to the consumers that they are furnishing cement of high quality which meets all the requirements of these patents.

It is my intention to give these licenses to all of the cement companies, who desire to use them, charging them a royalty of 1½c. per bbl. on all cement manufactured and sold according to the patents. Where a producer uses this method of testing cement and the royalty is paid at the mill no further charge will be made, but where the customer is using cement of this kind and it is not manufactured according to the patents and the consumer is working along this line, that is, accepting all cement which passes the test and rejecting that which does not, in this case he will be required to pay 1½c. per bbl. for all cement so tested.

Exceptions, of course, will be made where scientific investigation is being conducted, providing the parties desiring to use this method will communicate with the inventor and obtain permission.

Tests of Modern High-Speed Brakes on Fast Passenger Trains

On February 10, a paper was read before the New York Section of the American Society of Mechanical Engineers describing the tests made by the Pennsylvania Railroad last year on the new brakes for high-speed trains developed by the Westinghouse Air Brake Co. S. W. Dudley, the authority of the paper, is Assistant Chief Engineer of the Westinghouse Air Brake Co., and his printed paper occupies about 150 pages of the Society "Transactions." The tests described, however, are claimed to be the most important and thorough investigation of railway brakes that has taken place since the famous Galton-Westinghouse trials in England, in 1878 and 1879.

Space permits the presentation here of only the condensed summary of the paper which precedes it in the Society's imprint.

A train of 12 steel passenger cars and modern locomotive weighs nearly 1000 tons, is about 1000 ft. long and, at 60 m.p.h. speed has a kinetic energy of 224,000,000 ft.-lb.

With the ordinary high-speed brake apparatus such a train would be stopped by an emergency application of the brakes in a distance of from 1500 to 1800 ft. according to the truck rigging and brake-shoe design and installation.

In making ordinary brake applications for slow-downs or station stops, skill and judgment must be carefully exercised in order to avoid shocks and make short and accurate stops.

The Pennsylvania R.R. brake tests of 1913 showed that such a train at 60 m.p.h. speed can be stopped by an emergency application in 1000 ft. or within the length of the train. They also showed that trains can be controlled by service applications without shocks at any speeds and with greater accuracy and promptness and still require less expert knowledge and skill on the part of the manipulator.

The improvement in emergency stopping power has resulted from applying the air brakes more quickly and to a higher pressure, holding this higher pressure without diminution toward the end of the stop, using a more efficient design and better installation of foundation brake rigging and providing a better method of applying the brake shoe to the wheel and more brake-shoe metal to absorb the heat developed during the process of stopping.

The greater efficiency, economy and flexibility in service has been attained by making the air-brake apparatus more positive and responsive in its operation, both in application and release, enabling full advantage to be taken of all the possibilities of these improvements through the quick, simultaneous and flexible action obtainable only with electric control, the maintenance of a high and uniform brake rigging efficiency, and the improved truck, journal and brake-shoe action, less wear of brake shoes and better distribution of forces and reactions accompanying the use of the clasp brake

having two shoes per wheel, instead of concentrating the heavy braking forces required by modern equipment on only one side of the wheel.

The tests constitute a scientific study of the brake as a whole; comparing in detail the characteristics of the ordinary high-speed air-brake apparatus with the improved electro-pneumatic brake, the effect of low and high emergency braking powers, the clasp with the single-shoe type of brake rigging, the relative advantages of one and of two brake shoes per wheel and investigating the limitations of track and operating conditions commonly experienced.

The improved air-brake apparatus, operating pneumatically shortens the time of obtaining maximum emergency brake cylinder pressure on the train as a whole from eight seconds, with the PM equipment to 3.5 seconds and with electric control this is again shortened to 2.25 seconds. Moreover, 125%, 150% or 180% emergency braking power is available as may be thought desirable or found permissible according to circumstances when the installation is made. The PM equipment has an average of 100%.

Using 150% emergency braking power, the quicker and more powerful pneumatic emergency application shortened the stop at 60 m.p.h. from over 1600 ft. to about 1400 ft. and the simultaneous action of the electro-pneumatic brake still further shortened the stop to less than 1200 ft.

With the PM equipment the attempt to make an emergency application during the progress of or before releasing a partial or full service application will produce only the same stop as if merely a full service application had been made. Considering the ordinary full-service stop from 60 m.p.h. (say 2000 or 2200 ft.) as 100%; with the improved apparatus, operating pneumatically, an emergency application following a partial service application will shorten about 14% and after a full service application about 10%; with electro-pneumatic operation the gain is 23% and 15% respectively. This is a safety factor of great importance.

Shocks during brake applications are due to slack action modified by speed. This was shown by pneumatic and electro-pneumatic stops from both high and low speeds. At high speeds, 60 to 80 m.p.h., the serial action of the pneumatic emergency application resulted in noticeable shocks which increased in severity at lower speeds and at 10 m.p.h. amounted, in effect, to a collision between the rear and forward ends of the train, the train being stopped in 42 ft. The simultaneous application of just as great retarding forces by the electro-pneumatic brake entirely eliminated violent slack action at all speeds, the stop even at 10 m.p.h. (37 ft.) being without shock.

Station stops and emergency stops with the old and the new air-brake apparatus mixed in various ways in the train showed harmony in operation and improved general results, particularly when releasing brakes.

Comparative tests showed that when the improved air-brake mechanism is used on the cars, an arrangement giving a high emergency braking power on the locomotive, with blow-down feature, reduces shocks due to unequal braking power and shortens the stops.

With the electro-pneumatic brake a uniform increase in maximum per cent. braking power results in a substantially uniform decrease in length of stop, the decrease amounting to about 2% for each 5% increase in braking power within the range of these tests.

The available rail adhesion varies through wide limits; e.g., from 15% in the case of a frosty rail early in the morning to 30% for a clean dry rail at mid-day.

Wheel sliding depends more on the rail and weather conditions than on the per cent. braking power. Some sliding was experienced with braking powers as low as 90% when rail conditions were unfavorable, but 180% braking power did not cause wheel sliding with a good rail.

The effect of excessive wheel sliding was to make the length of the stop about 12% greater than similar stops without wheel sliding.

An expression for the relation between coefficient of rail friction f_r, efficiency of brake rigging e, and per cent. braking power P at the instant wheel sliding is about to occur derived from the data of the best tests made, is $P^{0.82} = \frac{8.33 f_r}{e}$.

An efficient design of clasp-brake rigging was shown to be necessary in order to avoid serious losses due to excessive piston travel, undesirable journal and truck reactions, brake shoe wear and variable shoe action.

The performance of the cast-iron brake shoe was shown to vary between wide limits, the ordinarily assigned causes for this variation (such as speed, pressure and time of action) becoming effective chiefly as they affect the temperature of the working metal of the brake shoe and wheel.

The amount of wheel and shoe metal in work[illegible] contact during a stop is very small and is the most diffi[illegible] factor to control. At the same time it is most potent i[illegible] reducing variations in brake performance.

The brake-shoe bearing area and consequently [illegible] generation of heat in the working metal and the resu[illegible] coefficient of friction was shown to vary considerably [illegible] ing the progress of a single stop and to a greater degre[illegible] the fit of the shoe to the wheel changed due to warping or [illegible] ntinued rubbing. Due to this effect alone the emergen[illegible] topping distance at 60 m.p.h. changed by as much as 20%.

This is evidence, however, that with reasonable [illegible] ttention to brake-shoe maintenance the condition of the shoes on cars in ordinary road service is likely to be more favorable to making short emergency stops than during a series of tests in which the brake shoes are worked severely.

Flanged shoes provide more available area for wearing than unflanged shoes and, when worn in, shortened the train stops about 12%.

The use of two shoes instead of one per wheel will result in a higher coefficient of friction and less wear per unit of work done, the durability under clasp-brake conditions being about 40% greater than under single-shoe conditions.

The use of two shoes per wheel permits a design of rigging which will enable flanged shoes to be used without danger of pinching flanges and causing excessive flange wear or non-uniform brake forces which result when flanged shoes are used with rigid beam connections.

The wear of flanged shoes is about 20% less than unflanged shoes.

From tests at 60 m.p.h. with clasp brake rigging, the relation between coefficient of brake-shoe friction f_s and per cent. braking power P, was found to be $f_s = \frac{0.12}{P^{0.42}}$. No satisfactory separate determination of brake rigging efficiency e, and coefficient of brake-shoe friction f_s, was made during the road tests. The combined effect $e \times f_s$ was obtainable with reasonable accuracy from the best of the several stops made under various conditions as given in the following table. The values for single-shoe conditions are more uncertain than the clasp-brake conditions due to less satisfactory data.

VALUES OF $e \times f_s$

Kind of brake rigging		Clasp brake		Single shoe[1]	
Type of brake shoe					
Speed m.p.h.	% braking power	Plain	Flanged	Plain	Flanged
30	125	0.141	0.169	0.108	0.112
	150	0.129	0.154	0.099	0.103
	180	0.118	0.141	0.090	0.094
60	125	0.103	0.122	0.074	0.090
	150	0.094	0.112	0.068	0.082
	180	0.086	0.102	0.062	0.075
80	125	0.092	0.109	0.070	0.074
	150	0.084	0.100	0.064	0.068
	180	0.077	0.092	0.059	0.062

[1] Value of data uncertain due to non-uniform brake-shoe conditions.

The length of emergency stop S_t, on a straight level track, neglecting air and internal friction on the one hand and the rotative energy of the wheels and axles on the other hand, can be calculated from the following formula:

$$S_t = 1.467\ Vt + \frac{V^2}{30\ P e f_s}$$

in which

V = Initial speed in m.p.h.;
P = Per cent. braking power actually realized;
$e \times f_s$ as determined by the existing brake rigging and shoe conditions (see table);
t = Time at the beginning of the stop during which the brakes are to be considered as having no effect, to allow for the time element in the application of the brakes.

KIND OF AIR BRAKE EQUIPMENT

For a 12-car train		PM	UC Electro-pneumatic
t ranges	from	2.0	0.70
	to	2.5	0.85

A train of 12 steel cars and locomotive with the electro-pneumatic brake, 150% braking power, clasp brake rigging, unflanged brake shoes can be stopped.

From 30 m.p.h. in 200 ft. equivalent to an average retarding force of 300 lb. per ton.

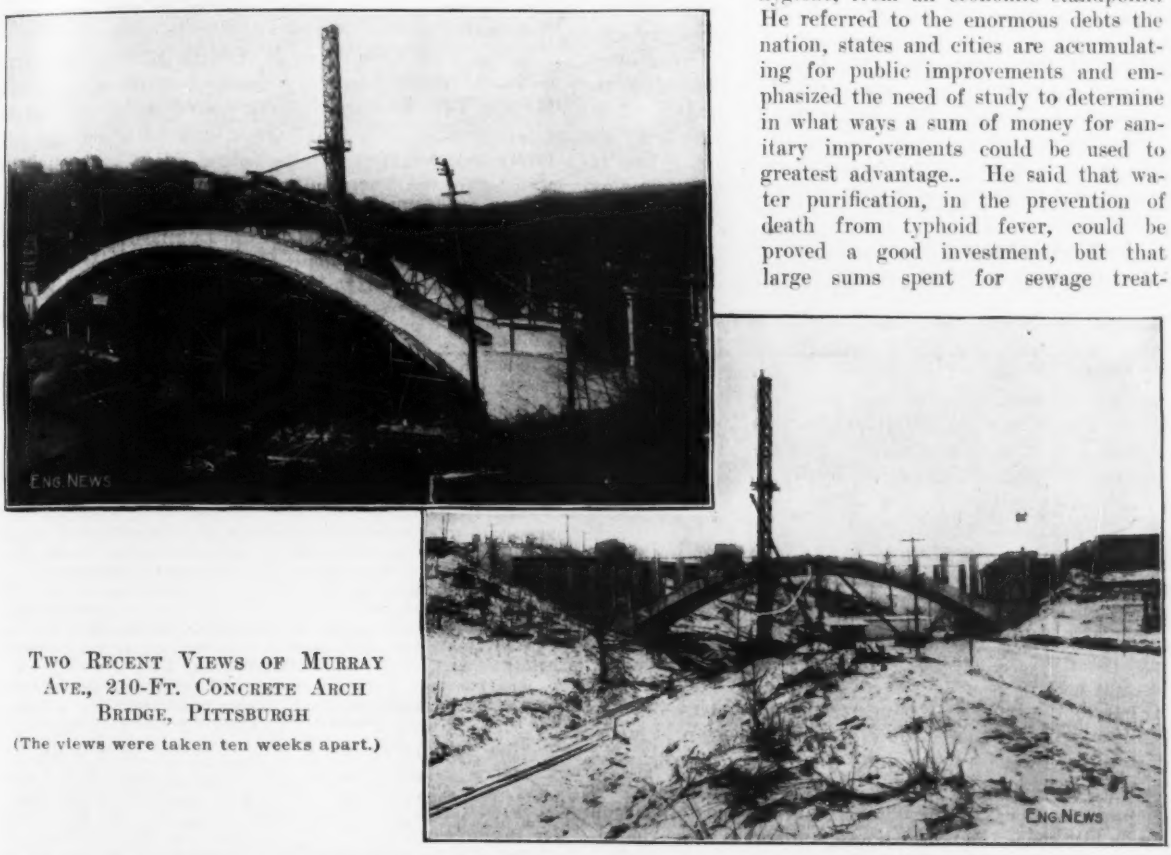
From 60 m.p.h. in 1000 ft. equivalent to an average retarding force of 240 lb. per ton.

From 80 m.p.h. in 2000 ft. equivalent to an average retarding force of 214 lb. per ton.

Murray Ave. Concrete Arch, Pittsburgh

The progress being made in constructing the 210-ft. Murray Ave. arch bridge in the Squirrel Hill district of Pittsburgh, Penn., is shown by the adjoining views of recent date. The left-hand view is about ten weeks earlier than the other, and, as will be seen, only the roadway column work went on in the meantime, except for striking and removing the centering.

The bridge takes the place of an old street-car trestle, and will provide a 40-ft. roadway carrying two car tracks, and two 10-ft. walks (60 ft. width of deck). The total length is 375 ft., of which the main span represents 210 ft. The cost is $150,000. The bridge is being built by the Dravo Contracting Co., for the city. About 5200 cu. yd. concrete and 200 tons steel (rods and structural metal) are required.



TWO RECENT VIEWS OF MURRAY AVE., 210-FT. CONCRETE ARCH BRIDGE, PITTSBURGH

(The views were taken ten weeks apart.)

The Annual Meeting of the Connecticut Society of Civil Engineers

The annual meeting held in Hartford, Conn., Feb. 10 and 11, was notable for being the 30th anniversary of the founding of the society. At the annual banquet on the night of Feb. 10, seven of the original fifteen founders were present. and they related many interesting reminiscences.

COMMITTEE REPORTS—The committee on conservation of water-supply had found, from a letter ballot, that a large majority of the members of the society were in favor of a State water-supply commission. The report of the committee on sanitation and public health recommended the passage of laws to increase the powers of the State board of health for the protection of water-supply and the prevention of stream pollution. The board at present has merely advisory powers. The committee on fees and code of ethics submitted a recommended schedule of fees, which was subsequently adopted, with the understanding that the proposed schedule was not obligatory, but was to be a guide only. This schedule is published elsewhere in this issue.

PAPERS

SANITATION, SEWERAGE AND WATER-SUPPLY—Prof. George C. Whipple, of Harvard University and New York City, read a paper on "Relative Values in Sanitation," in which he discussed briefly the various phases of sanitation, ventilation, water-supply, sewage disposal and hygiene, from an economic standpoint. He referred to the enormous debts the nation, states and cities are accumulating for public improvements and emphasized the need of study to determine in what ways a sum of money for sanitary improvements could be used to greatest advantage.. He said that water purification, in the prevention of death from typhoid fever, could be proved a good investment, but that large sums spent for sewage treatment were not so easy to justify from an economic viewpoint. The problem, he thought, was one to be solved by public-health engineers—men trained broadly enough to know and consider all phases of sanitation, and to use the public funds where the best, economic, sanitary and useful results would ensue.

The Hartford East Side sewage-pumping station was inspected, and later in the day the plant was fully described and illustrated by stereopticon views by W. S. Brewer, Assistant City Engineer. This station is a reinforced-concrete and brick building equipped with electrically-driven vertical-shaft centrifugal pumps for pumping sewage and storm water from a part of the east side of

the city, along the Connecticut River, during periods of extreme high water in the river. The pumping plant is part of a flood-prevention project which includes the construction of concrete dikes or retaining walls along the river front and a new intercepting sewer. The plant is designed to eventually pump all the sewage of this district to some future disposal works.

Sewer explosions were treated historically and descriptively in a paper by Henry J. Kellogg, Assistant City Engineer of New Haven, Conn. Due to some recent experiences in New Haven, the authorities there have started a nation-wide inquiry into the nature, causes and prevention of sewer explosions, for the primary purpose of drafting an ordinance to effectually prevent explosive gases and liquids finding a way into the public sewers. The possibility of explosions in sewer repair and cleaning work has been greatly lessened in New Haven by the use of small storage-battery electric lamps, and the forbidding of workmen to smoke or otherwise strike a light. The paper gave a valuable compilation of the experience of many cities throughout the country and was interspersed with humorous remarks which added much to the attention with which the reading was listened to. Notwithstanding the possibility of injury to persons on the streets as well as to sewer workers, only one or two fatalities are on record as having been caused by sewer explosions.

A small-pressure mechanical-filter plant installed by the New York Continental Jewell Filtration Co., at Canaan, Conn., was described by Kenneth W. Leighton, chemist in charge. The plant consists of four tanks each of 250,000 gal. per 24-hr. capacity and cost complete $21,000. The cost of operation including an allowance for depreciation is $248 per month. The amount of water filtered per month is 7,000,000 gal., so the cost of filtration per million gallons is $35.47. This does not include interest on the capital invested.

Hydro-Electric Power—The new Falls Village, Conn., hydro-electric development of the Connecticut Power Co., was described by E. A. Ekern, of the Stone & Webster Engineering Corporation, by whom the construction work was done. The plant is on the Housatonic River at a point where the watershed above is 640 sq.mi., and the river has an average minimum flow of 300 sec.-ft., but may be as low as 80 sec.-ft. The plant is capable of developing 9000 kw., with present equipment and 12,000 kw. with another unit, for which provision is made. From the intake at the falls the water is conducted through an old canal, built in 1850, recently relined with concrete, in place of the old masonry, to the forebay on a side hill above the power house, a distance from the intake of 1930 ft. From the forebay three 9-ft. riveted steel penstocks lead to three units of Wellman-Seaver-Morgan turbines and Allis-Chalmers alternating current generators. The 66,000-volt, 3-phase transmission line is carried on 4-leg steel towers, 57 ft. high, to surrounding towns. The plant cost about $1,200,000 and is the first high-tension system in the state.

Tests of Steel Transmission Towers—The tests described in this paper by Charles L. Nord and W. V. Barry were made at the University at Charlottenburg, in Germany, in 1910 and 1911. These tests showed clearly the importance of a good foundation, and, the authors of the paper believed, showed a need of revision of methods of computation by the accepted column formulas. The paper was discussed by C. R. H[illegible] of the New York, New Haven & Hartford R.R., and E. A. Ekern.

Direct Solar Observations for Azimuth—Walter H. Starkweather described the determination of azimuth using the formula developed by Louis Ross, of San Francisco, Calif., and the method described in an article by him in Engineering News, Mar. 6, 1913. Mr. Starkweather highly commended the method and the ease with which the work could be accomplished.

Highway Construction—Charles J. Bennett, State highway commissioner, described the Connecticut highway department organization and work. Mr. Bennett has given much time and thought to the business end of his department as well as the engineering end, and his paper contained many points of interest on the methods of keeping cost records, bookkeeping, and methods of keeping track of appropriations, which are as essential to the success of good roads building as the engineering features.

Effect of Amount of Water in Mixing Concrete—Some recent laboratory tests at Sheffield Scientific School, Yale University, were described and the results given by R. K. Skelton. These tests confirmed the generally well accepted fact that about 27½% by weight of water gave the best results in strength of concrete.

Officers—The following officers were elected: President, George K. Crandall, City Engineer of New London; First Vice-President, C. E. Elwell, Chief Engineer of the Connecticut Public Utilities Commission; Second Vice-President, Clarence Blakeslee, Civil Engineer and Contractor, of New Haven; Secretary and Treasurer, J. Frederick Jackson, of New Haven.

Recommended Schedule of Fees of the Connecticut Society of Civil Engineers*

The following schedule of charges for professional services are intended as a guide to engineers and their clients. It is believed that, in ordinary practice, a fair and proper compensation for engineering services will lie somewhere between the minimum and maximum charges given in the schedules. It is recognized, however, that the magnitude of the work and the experience or reputation of the engineer frequently justify a decrease or increase from the schedules below.

Charges may be based on any of the following methods, or a combination of the same, A, as a percentage of the cost of the work; B, a fixed sum; or C, a per diem rate.

(A) PERCENTAGE OF THE COST OF THE WORK

(1) For preliminary conferences, preliminary studies, estimates and reports, from 1 to 1½% of the cost of the work.

(2) For the services outlined in (1), for the design, and for the preparation of contract drawings, specifications, and contracts, a total charge of from 2½ to 5% of the cost of the work.

(3) For the services outlined in (2), for advice in letting contracts, and for general supervision during construction, a total charge of from 4 to 8% of the cost of the work.

(4) For full professional services, including complete supervision and inspection of construction, a total charge of from 6 to 12% of the cost of the work.

When no contracts are let, but the work is done under the business management of the engineer, the additional compensation depends to such an extent upon conditions that it should be a matter of special agreement between the engineer and his client.

In the preliminary stages the cost of the work is based on the estimated cost; later it is based on the cost of all labor and materials necessary to complete the work, plus the contractor's profit and expenses. The cost of both labor and

*Adopted at the annual meeting held in Hartford, Conn., Feb. 10, 1914.

materials should be based on market prices current when the work was ordered, the labor to be fully paid and the materials to be considered as new.

Payments should be made from time to time as services are rendered, the amounts to be based upon the proportion of services completed.

(B) A FIXED SUM

(1) A fixed sum for services may be agreed upon in lieu of a percentage or a per diem charge, and an additional charge made for expenses.

(2) A fixed total sum for all services of principal or assistants and for all attending expenses.

A fixed sum may be charged for a portion or all of the items of preliminary surveys, studies, examinations, reports, plans, specifications and supervision, etc., either with or without attending expenses.

(C) PER DIEM RATE

(1) For expert services, reports, consultations, opinions, expert testimony, depending on the experience of the engineer and the character, magnitude and importance of the work or subject involved, a charge of from $25 to $100 per day.

(2) For time of consulting engineer on designs and for more ordinary services, examinations, reports, etc., a charge of from $15 to $50 per day; seven hours of actual time to be considered one day, except that, while absent from home city or attending court, each day of 24 hours or part thereof shall be considered one day irrespective of actual hours of time devoted to the case.

Additional charges should be made for all actual expensess and assistants. The cost of assistants shall be determined by adding to the payment for wages 50% for overhead charges.

GENERAL PROVISIONS

Traveling expenses and expenses involved in making borings, soundings or tests, or in the collection of similar data necessary for the proper designing or planning of the structure or project, should be paid for by the client in addition to the commission herein provided for, it being understood, however, that all ordinary measurements and surveys shall be considered a part of the regular work of the engineer for which no extra compensation shall be expected.

When alterations or additions are made to contracts, drawings, or specifications, or when services are rendered in connection with legal proceedings, franchises or right-of-way, or failure of contractors, a charge based upon the time and trouble involved shall be made in addition to the commissions herein provided for.

It is recognized that in any work undertaken by an engineer there may be problems requiring the services of a specialist. The cost of such special assistance shall be paid by the client.

Drawings and specifications, by any method of payment for services, are to be considered the property of the engineer, but the client is entitled to receive one record of the same upon payment of the actual cost of making the copies if no duplicate set is at hand.

Good designing may be vitiated by poor construction, especially in any work which requires careful supervision and inspection during its progress, such, for example, as reinforced-concrete work.

For this reason it is for the best interests of the client that the engineer be given full direction of the work during the construction period, or, if this is impracticable, that the client employ experienced inspectors approved by the engineer and working under his general supervision.

EDWARD W. BUSH, JOHN C. TRACY, HERBERT C. KEITH,
Committee.

The National Conference on Concrete Road Construction

The convention to discuss methods of concrete-road building, held in Chicago last week, brought together between three and four hundred engineers and others interested in the subject.

A notable feature of the conference was the full attendance at every session. It is rather a common experience at technical conventions to see the members give their time to the "side shows" to the neglect of the regular meetings. At Chicago, there were no excursions and the Cement Show in the Coliseum was the only diversion. Those who came to attend the conference apparently attended every session and stayed from the opening to the close.

A couple of months ago, those arranging for the conference appointed committees on fifteen different topics. All but one of these committees made some sort of a report, and a number of them were distinctly valuable. The time available for the discussion of these reports was unfortunately too limited by reason of the full program and the time devoted to general addresses for these reports to be threshed over as thoroughly as was desirable; but those in attendance generally expressed themselves as well satisfied with what they had gained during the three days' meeting.

By far the most important and valuable committee report presented, was that of the Committee on Contraction and Expansion of Concrete Roads of which R. J. Wig, of the Bureau of Standards, was chairman, and the other members were N. H. Tunnicliff, of Davenport, La., and W. A. McIntyre, of Philadelphia.

The data presented by this committee show that the main cause of contraction and expansion of a concrete road, or for that matter of any concrete exposed to the weather, is not changes in temperature but *changes in moisture conditions.* While there has been more or less discussion of this subject by cement experts, it will come as a new idea to most engineers that concrete swells and shrinks every time it is wet and dried, just like a piece of timber, though of course not to the same degree. But it is established that the swelling and shrinking of concrete with changes in moisture is far greater than its expansion and contraction with changes in temperature. The Bureau of Standards has made most careful measurements on the experimental concrete road near New Village, N. J., and has found that the maximum expansion of the concrete in this road occurs in April when the road is thoroughly soaked by the winter's rain and snow and when the temperature has somewhat increased above that of the winter. The road then begins to shrink, notwithstanding the increasing temperature of summer and is shortest in August when it becomes most thoroughly dried out.

One important lesson from this discovery is the importance of a rich impervious mixture for concrete road work, so as to make the percentage of water absorption and consequent expansion as small as possible.

Another very important result of this committee's work is its recommendation that the subgrade of the road on which the concrete is laid be slightly dished instead of made flat or crowning. This tends to prevent longitudinal cracking of the road, as gravity tends to cause the two longitudinal halves of the road to slide toward the center, thus inducing compression in the road. Further, with the subgrade dished and the concrete surface crowned, the concrete will be much thicker in the center than at the sides, giving it greater strength to resist longitudinal cracking.

No other committee report presented approached the one above reviewed in originality and importance. They were in general summaries of present practice in the field which they covered. A number of them are abstracted separately elsewhere in this issue.

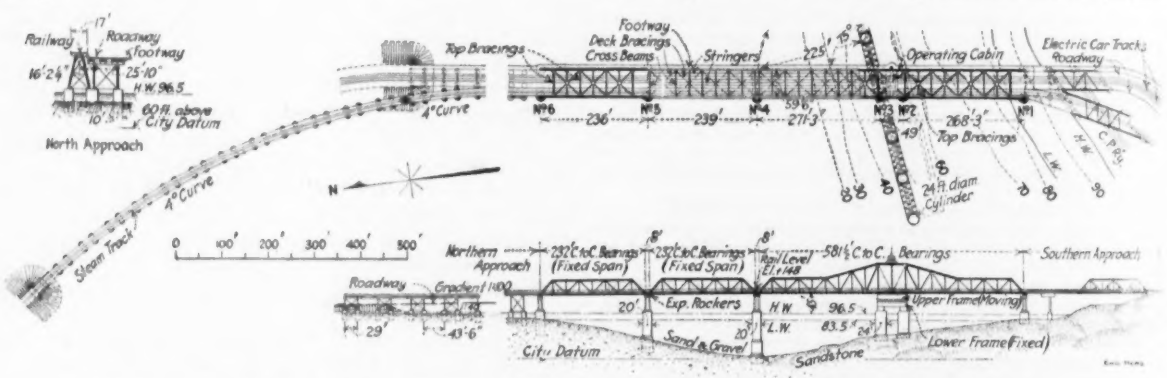
At the opening of the conference, a Committee on Resolutions was appointed; and at the closing session it presented a report summarizing all the committee reports and offering it for adoption by the Conference as "Recommended Practice" in concrete-road construction.

The report was accepted without discussion, subject to amendment and alteration by the Resolutions Committee, to which was also assigned the task of editing and publishing the Proceedings of the Conference.

The Advisory Committee, which had responsibility for the present conference, was also requested in its discretion to arrange for a second conference a year hence.

Bridge over Burrard Inlet at Second Narrows, Vancouver, B. C.; Record-Breaking Swing-Span

A bridge to be erected over the Second Narrows of Burrard Inlet, British Columbia, to connect Vancouver and North Vancouver, has been designed with a swing-span longer than any now existing. Its length of 581½ ft. between centers of end bearings will exceed the longest present swing-span by some 60 ft. As the bridge is to carry railway, highway and street-car traffic, its width, 59½ ft., also makes the swing-span an interesting piece of construction. The outline drawing herewith shows the bridge in condensed plan and elevation, as drawn by the firm of Sir John Wolfe Barry, Lyster & Partners, of London, Eng., with whom is associated the firm of Cleveland & Cameron, of Vancouver, as engineers for the bridge.



Design for Burrard Inlet Bridge to Connect Vancouver and North Vancouver, B. C.

North Vancouver has for some time needed a bridge, to get access to the railway, but until now the idea of a bridge had not led to active steps. Recent increase of traffic, however, and the advent of the Pacific Great Eastern Ry. (a branch of the Grand Trunk Pacific), brought the undertaking into existence.

The width of the river at the site is 1030 ft. at low-water mark and 3248 ft. at high-water mark. Its depth ranges to 96½ ft. at mid-channel at ordinary tide stage; the tidal range is 13 ft. The great depth of water, together with somewhat unsatisfactory soil conditions, makes the foundations of the bridge difficult and expensive. At the south shore there is soft sandstone rock; at mid-channel this stratum dips under a deposit of gravel and boulders, and at the north bank the ground is coarse and fine gravel (overlain by 6 ft. of silt) to a total depth of 155 ft. These soil data, in connection with the high velocity of tidal currents through the Narrows (7 knots) and the fact that the bottom flow continues for two hours after the turn of the tide, which makes diving operations difficult, called for careful study of the foundation problem. Cylinder piers on piles are to be used for most of the substructure. The fender pier (in line of the position of the swing-span when open) also consists of cylinder piers, with bracing and fender work on each.

A clear waterway of 225 ft. measured square to the channel was required by the government. The bridge crosses at an angle of 75°, i.e., skewed 15° from square. The clearance above high water of ordinary spring tides will be 45 ft.; this height also gives a clearance of 124½ ft. over the Canadian Pacific Ry. tracks on the south bank. The channel depth under the north arm of the swing-span will be 35 ft. minimum.

As to deck, the bridge is to carry, between trusses, a single railway track on the west side, and east of this a roadway 37 ft. 5½ in. wide between curbs, the roadway including two electric-car tracks; an 8-ft. sidewalk is carried on brackets outside of the eastern truss.

The main portion of the bridge consists of two fixed spans of 232 ft. c. to c. length, and the 581½-ft swing-span. The north approach consists of a plate-girder viaduct with tower spans of 29 ft. and intermediate spans of 43 ft. In each bent the railway portion of the tower is 8 ft. wide with posts battered 1:4½, while the highway portion is 26 ft. wide with vertical posts. The south approach will consist of two skew bridges side by side over the Canadian Pacific tracks. The highway portion of this span will be 108 ft. long, and the railway portion 168 ft. long. Short plate-girder spans connect this span with the end of the river bridge.

A Car-Ferry Steamer with movable train deck has been built by Cammell & Laird, of Birkenhead, England, for the Transcontinental Ry. of Canada. The vessel is to transfer through trains across the St. Lawrence River, between Quebec and Levis, until such time as the Quebec Bridge is put in operation. The vessel is 326 ft. long and 16-ft. beam, with a draft of about 15 ft. There are twin screws at the stern for propulsion and a single ice-breaking screw at the bow. The special feature is the elevating deck designed to meet the tidal conditions. This deck is 275 ft. long and has three tracks. The ends of its floor beams carry threaded steel castings on nuts riding on ten vertical screws, the screws being supported by a framework of columns and bracing. The screws are suspended from the top by ball-bearings and are operated by worm gears from horizontal shafts driven by a four-cylinder engine beneath the main deck. The gearing is designed to raise the deck when fully loaded with about 1400 tons of locomotive and train. The range of vertical travel is 20 ft., and the speed about 1 ft. per minute. A hinged apron at each end of the deck provides the connection with the landing stage. Above the top of the lifting framework is a promenade deck, at the forward end of which are the pilot house and navigating bridge. Electric winches are fitted for hauling cars on and off when required.

Reports of the National Conference on Concrete Road Building

SYNOPSIS—Abstracts of some of the more important Committee reports presented at the National Conference on Concrete Road Building held at Chicago, Ill., Feb. 12-14, 1914.

Aggregates for Concrete Roads

The successful development of the concrete pavement depends upon: (1) Materials, and (2) Workmanship.

It is not so much a question as to whether concrete is a suitable material for roads in comparison with other paving materials, as it is a comparison between concrete and concrete. The durability depends upon the character of the concrete.

Examination of letters received by the Chairman of this Committee from a large number of cities having concrete roads shows general satisfaction with this type of pavement. Adverse criticism usually comes from cities where the specifications and description of work indicate either poor materials and incorrect proportions or improper methods of construction.

AGGREGATE ESSENTIALS

Simple rules covering the most essential requirements are as follows:

(1) For fine aggregate, use only sand or other fine aggregate that has been actually tested for mechanical analysis and tensile strength of mortar, and is free from fine particles.

(2) Use coarse-grained sands or hard stone screenings with dust removed.

(3) Use sand or other fine aggregate that is absolutely clean.

(4) For coarse aggregate, use hard stone, such as granite, trap, gravel, or hard limestone.

(5) If bank gravel or crushed stone is used, always separate the sand or screenings and re-mix in the proper proportions.

If local conditions prevent following any one of these rules, adopt some other material than concrete for your pavement.

Briefly taking up each one of these points:

(1) Actual laboratory tests are necessary for fine aggregates, because it is impossible for the most expert builder to always distinguish by appearance between good and poor sands. Sand may be coarse, of good color, well graded, and apparently perfectly clean, and yet because of a minute quantity of vegetable matter may show practically no strength when made into mortar or concrete. Case after case has been found where good-looking sand had to be rejected on laboratory test or, if used, produced defective concrete.

(2) Coarse sand is necessary not only for strength and density, but to prevent the formation, on or near the surface, of a layer of fine material, consisting of a mixture of dust and cement which has no durability. Mortar made with fine sand or sand having a large proportion of fine grains of silt, hardens slowly and is especially objectionable in cold weather. This prevents it attaining proper strength before the road is thrown open to traffic. A sand having a considerable proportion of fine particles may possibly show high briquette tests, and yet the mortar not have good resistance to attrition or wear.

(3) Sand must be absolutely free from vegetable or organic matter, or it is liable to harden not at all or too slowly to be serviceable. Frequently, sand may be entirely satisfactory in appearance, and yet be worthless for concrete. Defective sand of this type is apt to be taken from too near the surface of the ground, so that it contains a very small percentage of vegetable loam. At least 2 ft. of top soil and loam should be removed before using the sand, and in many cases it is necessary to take off as much as 4 or 5 feet, while occasionally no acceptable sand can be found in the entire bank because of the penetration to a great depth of the deleterious vegetable material.

(4) A coarse aggregate of hard quality is necessary to resist the wear and abrasion of hoofs and wheels. Failures of concrete roads have been caused simply by the softness of the coarse aggregate. In one instance, for example, shells were used for the aggregate, and the road went to pieces as soon as it was subjected to wear.

All stone, like shale, slate, shells and soft limestone, must be rejected; while trap, granite and conglomerate, are especially suitable materials. A hard limestone, such as that occurring in certain localities along the Hudson River, which is sold in New York as trap rock, is satisfactory for concrete roads. A hard limestone cannot be cut with a knife and the specific gravity is high, say, over 2.70.

Gravel does not bond quite so strongly with cement as does broken stone. When properly screened and free from dirt, however, and remixed with sand in the proper proportions, a good surface can be made even for a one-course pavement.

(5) Many roads that are now being built will prove worthless because of the use of sand taken directly from the bank without screening. If the gravel contains as much as 40% of stones and very rich proportions are used, say one part cement to 3½ parts bank gravel, a fair concrete can sometimes be produced, but it is always cheaper in such cases to screen the gravel and remix the sand and stone in proper proportions. There will be, for example, a saving of ¼ bbl., or 1 bag, of cement per cu.yd. of concrete by using proportions one part cement to 2 parts sand to 3 parts screened gravel, instead of using the unscreened bank gravel in proportions 1:3½. This difference will more than pay for the additional cost of screening the sand and rejecting part of it. At the same time, the result will be more uniform and the surface more durable because of the stones which take the wear. When an excess of sand is used in the mixture, as is the case with run-of-the-bank gravel, the mortar rises to the top when the concrete is placed and the wearing surface is less resistant than a mix that is uniform throughout.

If the rules given above are followed, and at the same time proper foundations, proportions, and workmanship, are obtained, the concrete pavement will prove durable and will resist ordinary traffic.

Tentative specifications for aggregates are presented as follows:

FINE AGGREGATES

QUALITY—Fine aggregate shall consist of sand or screenings from hard, durable gravel, granite, trap, or other hard rock. It shall be clean, coarse, hard, free from dust, loam, vegetable, or other deleterious matter. Fine aggregate containing frost or lumps of frozen materials shall not be used.

SAMPLES FOR TEST—Average samples of fine aggregate weighing not less than 10 lb. shall be taken from the bank or pile and tested, before the acceptance of the material, for fineness and for tensile strength in mortar. Individual average samples shall be taken from each bank to be used, and new samples taken in case of a change in the character of any one bank.

Receptacles for shipment to laboratory shall be such as to retain the natural moisture in the sand.

FINENESS—The size of the fine aggregate shall be such that the grains pass when dry a screen having ¼-in. openings. In the field a ⅜-in. mesh or, in some cases, a ½-in. mesh screen may be used for this separation.

Not more than 10% of the grains below the ¼-in. size shall pass a sieve having 50 meshes to the linear inch, and not more than 2% shall pass a screen having 100 meshes to the linear inch.

TENSILE STRENGTH OF MORTAR—Mortars composed of one part portland cement and three parts fine aggregate, by weight, when made into briquettes shall show a tensile strength at least equal to the strength of 1:3 mortar of the same consistency, made at the same time, and with the same cement and standard Ottawa sand. The sand shall not be dried before being made into briquettes, since this sometimes improves its quality, but correction shall be made for moisture when weighing the materials.

Tensile tests may be made at ages of 72 hours, 7 days and 28 days. At early periods the strength need not attain the full ratio of 100% to standard sand mortar, provided this is attained at a later period. In no case, however, shall sand be accepted for pavement work whose strength in 1:3 mortar at the age of 72 hours is not at least 80% of the strength of the standard sand mortar.

SCREENING—If bank gravel or crushed stone is used, it must be screened and remixed in the proper proportions.

If the sand does not fulfill the above requirements for fineness, it shall be washed, or else screened when dry over a 10-mesh screen placed at such an angle as to remove the particles finer than a No. 50 sieve.

WASHING—Fine particles may be removed by washing with a large volume of water in a box provided in the bottom with perforated pipes and arranged for the silt and water to flow off through a trough from the top of the box and the sand to be drawn out from below.

COARSE AGGREGATE

QUALITY—The coarse aggregate shall consist of clean, hard, durable granite, trap, conglomerate, gravel, or other hard rock, free from dust, loam, vegetable or other deleterious matter. In no case shall coarse aggregate be used which contains frost or lumps of frozen material.

Coarse aggregate containing soft particles shall be rejected.

Coarse aggregate shall not contain a large proportion of flat or elongated particles.

FINENESS—For one-course pavements, the size of the

coarse agregate shall be such as to pass an inclined or rotary screen having 1½-in. circular openings and be retained on a similar screen having ¾-in. openings.

For two-course pavements, the size of the coarse aggregate for the bottom course shall be such as to pass an inclined or rotary screen having 2-in. openings and be retained on a similar screen having ¾-in. openings.

For the wearing course in a two-course pavement, the coarse aggregate shall be of a size that will pass an inclined or rotary screen having ¾-in. circular openings and be retained on a similar screen having ¼-in. openings.

NATURAL MIXED AGGREGATES

Natural mixed aggregates shall not be used as they come from the bank or crusher, but shall be screened and remixed in the proper proportions.

S. E. THOMPSON, A. N. TALBOT, W. M. KINNEY, Committee.

Preparation and Treatment of Subgrade for Concrete Roads

The fundamental requirement of the subgrade is that it shall at all times be of uniform density, so that it will not settle unevenly and cause cracks in the concrete surface. Some engineers apparently believe that it is not necessary to take as much care in preparing the subgrade or foundation of a concrete pavement as of other forms of roads having an artificial surface, because the concrete slab will act as a bridge over any soft streak or low spot in the foundation; but the Committee is of the opinion that this is a mistake. The strength of a plain concrete slab in acting as a beam to carry the load over a low spot or soft place in the foundation is very slight; and it is so easy to remove the low place or soft spot as not to justify the dependence upon the beam action of the concrete. Any uneven settlement of the foundation of a concrete pavement is nearly certain to cause a crack.

If the concrete pavement is to be constructed upon an old roadbed of any kind, great care must be taken in preparing the subgrade. The old roadbed is likely to be more compact in the center than at the sides; and, consequently, there is danger that the concrete pavement will settle more at the sides than at the center, and, therefore, will crack longitudinally. Further, it is likely that the traveled way of the old road will not at all places be central under the new concrete pavement, and consequently, the latter will settle unevenly and crack.

When the subgrade is an old roadway, it is not sufficient to roll the subgrade longitudinally, since the roller is likely to balance upon the more compact central core, and, therefore, not consolidate the soil at the side of the old roadway. It is not necessary to attempt a detailed description of the method of overcoming this difficulty; but the engineer should be alert to determine whether this condition obtains, and when it does occur he should take the necessary precautions to secure a thorough consolidation of all parts of the new roadbed. It may be necessary to add material at the side of the more compact central core of the old roadway, or it may be wise to roll the roadway diagonally, or perhaps transversely. In extreme cases it may be necessary to loosen the old roadbed by spiking or scarifying, and then harrow it, and finally consolidate the entire new roadbed with the roller. The Committee desires to emphatically assert that the need of care in this matter is not imaginary, and that such conditions do really occur in actual practice.

DRAINAGE

The drainage of the roadbed of a concrete pavement is of vital importance. If the subgrade is not well drained, there is danger that after the concrete is laid, the drying of the soil under the edges of the concrete may permit the pavement to settle and thus cause longitudinal cracks on the surface. Further, if the subgrade is not well drained, there is a possibility that the frost may lift the edges of the concrete roadway and cause a longitudinal crack, at least on the lower side and possibly also upon the upper surface of the concrete. It is hardly possible in a report of this character to give detailed instructions for the adequate drainage of the roadbed for all kinds of soil and for all conditions, but a few remarks may be permissible.

If the soil is sandy, there is a possibility that the natural under-drainage is sufficient for the purpose.

If the soil is only moderately retentive, it will probably be sufficient to lay a line of ordinary farm tile along each side of the concrete pavement. The tile should be at least 4 or 5 in. in diameter, should be laid 2½ to 3 ft. below the surface, and should have sufficient fall to free itself promptly and fully. It is better to lay the tile outside of the edge of the concrete slab than under it. If the soil is a little retentive, some engineers put a layer of coarse gravel or broken stone immediately above the tile to facilitate the entrance of the water into the tile.

If the soil is quite retentive, it is wise to make more elaborate provisions than above for the drainage of the subgrade. For this case, it is recommended that a shallow longitudinal ditch be constructed just outside of the edge of the concrete slab. This ditch should extend about 8 or 10 in. below the surface of the roadbed, that is, below the bottom of the concrete slab; and should be filled with coarse gravel or broken stone. From this longitudinal ditch short transverse ditches should be dug across the shoulder to the ditch at the side of the roadway. These transverse trenches should have a grade sufficient to permit them to carry the water promptly and fully to the side ditch. In particularly retentive soil, these transverse trenches should not be placed more than 50 ft. apart. On level stretches, these transverse ditches should be practically at right angles to the direction of the road; but if the road is on a grade, these trenches should make an acute angle with the roadway, the amount of this angle depending upon the grade of the road. The sloping of these lateral trenches down hill makes it unnecessary to have the ditches at the sides of the roadway as deep as would otherwise be required. These lateral ditches should be filled level full with broken stone or coarse gravel to a point at least a little beyond the outer edges of the shoulders and preferably nearly to the bank of the ditch at the side of the roadway.

IRA O. BAKER, A. R. HIRST, A. N. JOHNSON, Committee.

Proportion and Consistency of Materials for Concrete Roads

Any specification for proportion and consistency of materials for concrete pavement must be general and suggestive, rather than mandatory; adaptive, not rigid. The cement problem has been standardized but the aggregate problem has not. Each locality must conform its practice to meet local conditions of material, soil, climatic and traffic.

Ideal paving concrete is a combination of perfect mineral aggregates and cement in such proportion as will give the greatest possible density, and in which, for economical consideration, the cement content is the least possible, consistent with ultimate strength and durability. Relative cost of material may justify greater thickness of base with less crushing or tensile strength per unit area.

Two Course Pavement

BASE PROPORTIONS—For sound, hard limestone or gravel having 40% voids, screened washed bank sand having 30% voids and portland cement, passing the standard specifications of the American Society for Testing Materials, the proportions should be 1 sack of cement, 2½ cu.ft. of sand and 5 cu.ft. of crushed stone or gravel, the aggregate having been so proportioned as to eliminate the voids as far as practicable.

CONSISTENCY—The amount of water should be such as to make the concrete plastic and still retain its shape, such as is commonly called a quaking mixture. Methods and distance of transportation before depositing will be factors in determining the amount of water used; concrete deposited from buckets, traveling along a boom, may have more water added than when wheeled for a considerable distance in barrows or carts. In the latter case the unavoidable shaking brings the lighter materials to the surface and causes a segregation of the materials, which results in an improper mixture when deposited.

Wearing Course

PROPORTIONS—The fine aggregate for wearing course shall be mixed with portland cement in the proportion of 1 sack of cement to 2 cu.ft. of the graded mineral aggregate. While this furnishes a considerable excess of cement we get greater impermeability.

CONSISTENCY—Sufficient water shall be used with the fine aggregate to form a mortar that will work easily under the template and at the same time retain its shape when deposited.

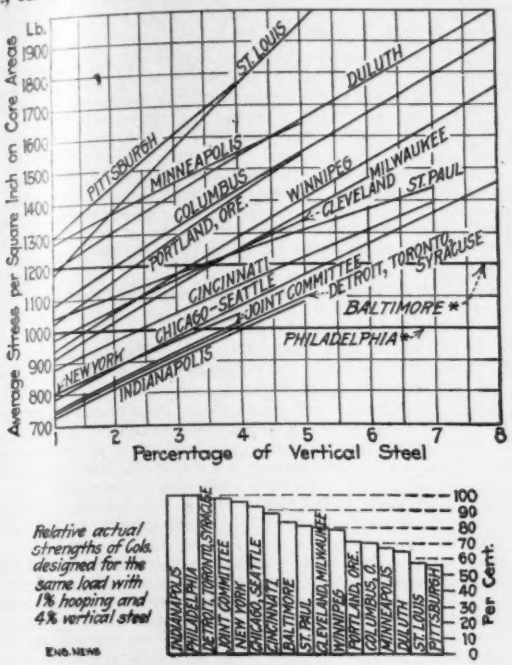
C. U. BOLEY, C. C. WIDENER, GEO. A. DINGHAM, Committee.

(To be continued)

Reinforced-Concrete Columns in Various Building Codes

The diversity of practice in the allowable unit stresses and in the strength of spirally-hooped reinforced-concrete columns as stipulated in the building codes of 20 American cities is shown by the accompanying diagram.

The diagram also shows how far many of the building-code requirements are from the recommendations of the Joint Committee on Concrete and Reinforced Concrete of the several engineering societies. The diagram was submitted before the Western Society of Engineers, Chicago, Ill., on Feb. 9, 1914, by T. L. Condron, of the Condron



COMPARISON OF ALLOWED UNIT STRESSES AND RELATIVE STRENGTHS OF SPIRALLY-HOOPED, REINFORCED CONCRETE COLUMNS

(Each diagram is for columns with 1% spiral hooping and of 1:2:4 concrete.)

*Baltimore and Philadelphia give unit stresses without fixing percentages of steel.

Co., structural engineers, Chicago. Mr. Condron believes that safety lies near the lower limit of the group of curves shown; in other words, that the upper curves represent a serious reduction of safety-margin.

NOTES

Work on the San Diego Exhibit Buildings of the San Diego Exposition to be held in that city in 1915 is progressing. All these buildings must be ready for the installation of exhibits, etc., by July 1, 1914. According to a recent statement by the Exposition authorities the viaduct over Tabrillo Cañon at the west entrance will be completed before Mar. 1. This will permit the handling of material for the remainder of the construction work over a much shorter and more convenient route. Work on the main group of buildings is nine weeks in advance of the original schedule.

The 85-Ft. Level of Gatun Lake, Panama Canal, was reached for the first time on Feb. 3. This is the normal level for which the canal is designed. On the same day seven, or one-half the total number, of the gates at the Gatun spillway were opened in order to test the electrically operated control system. One of the popular tourist excursions on the Isthmus nowadays is a sightseeing barge trip through Gatun Lake. For this purpose a new Panama R.R. barge, which can accommodate 300 passengers, has been brought into service.

The Patent on Wet Concrete, taken out by Alexander D. Ney and noted in "Engineering News," Dec. 9, 1909, p. 643, has been declared void by the United States District Court of the Northern District of Illinois. The patent (No. 939,072) claimed originality on the use of a wet mix in concrete. The patentee brought suit for infringement against the City of Aurora, Ill.

The court decided that the patent was void because the method of pouring concrete out by using a wet mix was a common practice some years before the issuance of the patent on Nov. 2, 1909.

Canada's National Transcontinental Ry., the construction of which has been for years the subject of wholesale charges of graft, has just been reported upon by two government commissioners, F. P. Gutelius, M. Can. Soc. C. E., and J. Lynch Staunton. According to telegraphed summaries of their report, which was presented on Feb. 12 to the Canadian Parliament, the original estimate of the government engineers as to the cost of the road was $61,415,000. The cost to date, however, is $161,300,000, and including the interest on the bonds, which must be paid by the government for seven years after completion of the road until the responsibility is assumed by the Grand Trunk Pacific Ry., the total cost will eventually reach $237,650,000. The investigating commission states that without including the money unnecessarily expended east of the St. Lawrence River, $40,000,000 at least was needlessly spent in the building of this road.

Further Damage at Seabright, N. J., from the action of the sea during high tide occurred on Feb. 14. Ocean Ave. was flooded, cellars were inundated, several small houses were washed away and a number of buildings were undermined. Bulkheads which withstood the battering of the two storms of Dec. 25-26 and Jan. 3-4 ("Eng. News," Jan. 8, p. 102 and Jan. 22, p. 168) were badly damaged. Another washout occurred on the Central R.R. of New Jersey at Normandie, where the roadbed was damaged by the January storm.

The Shackleford Bill for Federal aid to road construction and repair passed the House of Representatives on Feb. 10. The bill provides that the government may aid road construction in the several States to an amount of not more than $25,000,000 per annum. The division among the States is to be made by giving each State $65,000 and the balance is to be divided one-half, according to the population of the State and the other half according to its total mileage of rural post roads. The amount to be paid by the federal government is limited to $60 per mile per annum for macadamized roads, $30 per mile for gravel, shell or sand-clay roads, and $15 per mile for earth roads kept graded and dragged. It is currently reported that the favorable vote in the House of Representatives was given on account of the political necessities of the representatives, and with the understanding that the bill would either be killed or amended out of all semblance of recognition to its original form by the Senate.

L. B. Adams, of 1 Broadway, New York City, was arrested by the U. S. Postal authorities on Feb. 6, charged with using the mails for fraudulent purposes. Adams claims to be a dealer in investment securities. He has written to many concerns, taking names, we are informed, from the columns of "Engineering News" and other journals offering to undertake the sale of their securities, representing that he maintains a selling force, and proposing to circularize several thousand investors for an advance fee of $200 to $1000, and 10% commission on stocks sold.

The Government claims that Adams does not carry out the circularization as agreed and that he does not maintain a selling force in the field as he claims and is not in a position to sell the securities. If any readers of "Engineering News" have paid a fee to Adams for which they have received no return, they will do well to communicate with Mr. H. B. Mayhew, Post Office Inspector at New York City.

A Device for Cleaning Small Water-Service Pipes was described by Geo. H. Finneran, of the Boston water-works, at a meeting of the New England Water Works Association on Feb. 11. The author stated that the device had been of great benefit in cleaning out small pipes without the use of rods, which cannot be used unless the pipe has been carefully laid without abrupt bends. A proving or testing pump is cut into the service pipe, usually in the cellar. This pump is capable of a very high pressure, although in practice 200 lb. or a little more is rarely exceeded. In front of the pump is introduced a wad of any paper easily dissolved in water. This permits the pressure to accumulate as the force pump—which is usually fed from an ordinary hand pump drawing from a pail of water—starts operations. This plug of paper is slowly forced through the service pipe out into the main, thoroughly cleaning the service pipe. Cases where the bore of the pipe diminishes as it approaches the main, and also where the cock at the main is all but closed from dirt and corrosion, have yielded to this treatment.

PERSONALS

Mr. F. W. Davis, Jr., has been elected President of the Detroit Graphite Co., Detroit, Mich.

Mr. Tom R. Wyles has been elected Vice-President of the Detroit Graphite Co., Detroit, Mich.

Mr. James E. Sutton has been appointed City Engineer of Alameda, Calif., succeeding the late I. N. Chapman.

Mr. J. H. Jackson has resigned as Superintendent of the St. Louis & San Francisco R.R., at Birmingham, Ala.

Mr. A. H. Kutche, recently Superintendent of Public Works of Owosso, Mich., has been appointed City Manager of Monroe, Mich.

Mr. George St. Pierre, formerly Master Mechanic, has been promoted to be Superintendent of Equipment of the Oakland Terminal Rys., Oakland, Calif.

Mr. Henry Clay Hall, a lawyer of Colorado Springs, Colo., has been nominated by President Wilson to be a member of the Interstate Commerce Commission.

Mr. Lewis D. Freeman, Chief Draftsman of the Kansas City Southern Ry., Pittsburg, Kan., has been appointed Mechanical Inspector of the Seaboard Air Line Ry., at Portsmouth, Va.

Mr. Arthur L. Mills, formerly Manager of the Toledo, St. Louis & Western R.R., has been appointed General Manager of the Fort Smith & Western R.R., succeeding Mr. W. N. Bushnell, resigned.

Mr. T. W. Heintzelman, Superintendent of Motive Power of the Southern Pacific Ry., San Francisco, Calif., has been promoted to be General Superintendent of Motive Power, succeeding Mr. H. J. Small.

Mr. T. W. Younger, Superintendent of Motive Power of the Southern Pacific Ry., at Portland, Ore., has been transferred to Sacramento, Calif., to succeed Mr. T. W. Heintzelman, promoted as noted elsewhere.

Mr. J. C. Resch, recently Division Engineer of the Texas & Pacific Ry., at Big Spring, Tex., is now Assistant Chief Engineer of the International & Great Northern Ry., with headquarters at Houston, Tex.

Mr. G. Le Boutillier, recently Division Engineer at Pittsburgh, Penn., of the Pennsylvania R.R. Lines West of Pittsburgh, Southwest system, has been promoted to be Superintendent of the Richmond division.

Mr. D. W. Campbell, formerly General Superintendent of the Northern district of the Southern Pacific Ry., at Portland, Ore., has been appointed to the newly created position of Assistant General Manager at Portland.

Mr. C. H. Chenworth, Assistant Engineer of the Atlantic Coast Line R.R. at Savannah, Ga., has been promoted to be Engineer of Roadway, with headquarters at Savannah, succeeding Mr. O. T. Waring, promoted.

Mr. H. V. Platt, formerly General Superintendent of the Southern district of the Southern Pacific Ry., at Los Angeles, Calif., has been appointed to the newly created position of Assistant General Manager, with offices at Los Angeles.

Mr. F. G. White, former Signal Inspector of the Great Northern Ry., at St. Paul, Minn., has been appointed Signal Engineer of the Chicago Great Western Ry., with headquarters at Chicago, Ill., succeeding Mr. J. Beaumont, resigned, as noted in our issue of Feb. 5.

Prof. Winthrop More Daniels, Chairman of the Board of Public Utility Commissioners of New Jersey, has been nominated by President Wilson to be a member of the Interstate Commerce Commission. Mr. Daniels was formerly Professor of political economy at Princeton University.

Mr. C. S. Lake, recently General Superintendent of the Minneapolis & St. Louis R.R., at Minneapolis, Minn., has accepted the same position with the Chicago & Alton R.R., at Chicago, Ill. Mr. Lake was formerly a Division Superintendent of the New York, New Haven & Hartford R.R.

Mr. C. C. Williams, Assoc. M. Am. Soc. C. E., has resigned as Assistant Professor of civil engineering at the University of Colorado, to become Professor of railway engineering at the University of Kansas, succeeding Mr. B. J. Dalton, M. Am. Soc. C. E., resigned, as noted in our issue of last week.

Mr. James A. Coffey, formerly Manager of the waterproofing department of the American Asphaltum & Rubber Co., New York City, has been appointed Manager of New York City office, at 103 Park Ave., of C. S. Garrett & Son, Waterproofing Engineers and Contractors, Philadelphia, Penn.

Mr. J. W. Bennett, Deputy Commissioner of the Department of Water Supply, Gas and Electricity of New York City, has resigned to become Consulting Engineer of the Borough of the Bronx, New York City, at a salary of $7200 per annum. His salary as Deputy Commissioner was $6000 per annum.

Mr. Amos Schaeffer, M. Am. Soc. C. E., formerly Consulting Engineer of the Borough of the Bronx, New York City, has been appointed Consulting Engineer of Sewers of the Borough of Manhattan, New York City, succeeding Mr. Horace Loomis, M. Am. Soc. C. E., retired, as noted in our issue of Jan. 8.

Mr. P. L. McManus, Superintendent of the Chicago, Indianapolis & Louisville Ry., at Lafayette, Ind., has been promoted to be General Manager, succeeding Mr. A. H. Westfall, resigned. Mr. McManus began his railway experience at 13 years of age as a water boy on the Chicago & Alton R.R., in 1879.

Mr. E. E. Kerwin, former Superintendent of the New Jersey Central and Lehigh & Susquehanna divisions of the Central R.R. of New Jersey, is now General Superintendent of the Minneapolis & St. Louis R.R., at Minneapolis, Minn., succeeding Mr. C. S. Lake, resigned, as noted elsewhere.

Mr. O. T. Waring, formerly Engineer of Roadway of the Atlantic Coast Line R.R., at Savannah, Ga., has been promoted to be District Superintendent at Waycross, Ga. Mr. Waring is a graduate of the University of Pennsylvania, class of 1902, and was formerly a member of the engineering corps of the Baltimore & Ohio R.R.

Mr. A. P. Prendergast, formerly Superintendent of Motive Power of the Baltimore & Ohio R.R., at Baltimore, Md., has been appointed Superintendent of Machinery of the Texas & Pacific Ry., with headquarters at Marshall, Tex., succeeding Mr. F. S. Anthony, resigned. Mr. Prendergast has had 20 years of continuous experience with the Baltimore & Ohio R.R., having entered the mechanical department in 1893 as an apprentice.

Messrs. C. J. Paterson, Assoc. M. Am. Soc. C. E., recently with the Republic Structural Iron Works, Cleveland, Ohio, and R. I. Leitch, formerly with the Corrugated Bar Co., Buffalo, N. Y., have incorporated under the name of the Paterson-Leitch Co., to deal in reinforced-concrete supplies, with headquarters at Cleveland. Both men are technical graduates and are experienced in reinforced-concrete design and construction.

Mr. A. S. Zinn, M. Am. Soc. C. E., whose resignation as Resident Engineer of the Fourth division of the Panama Canal was noted in our issue of Jan. 15, has accepted the position of Consulting Engineer of the Department of Public Works of the Republic of Panama. Mr. Zinn is spending a six weeks' vacation in the United States, after which he will return to the Isthmus. Mr. Zinn succeeds the late Ricardo M. Aranzo, M. Am. Soc. C. E.

Mr. C. S. Krick, Superintendent of the Terminal division of the Pennsylvania R.R., at New York City, has been transferred to the Philadelphia, Penn., Terminal division to succeed the late J. B. Baker. Mr. Krick graduated in civil engineering at Lafayette College in 1887 and had completed 20 years' experience in the engineering departments of the Pennsylvania R.R. when he was appointed Superintendent of the New York Terminal division in 1907.

Mr. Leonard B. Allen, formerly Engineer of Maintenance-of-way of the Chesapeake & Ohio Ry., has been promoted to be Superintendent of the Huntington and Big Sandy divisions at Huntington, Va. Mr. Allen is a native of Kentucky and graduated from Kentucky State College in 1899. His railway experience began as a rodman on the Southern Ry. After a few months he joined the engineer corps of the Chesapeake & Ohio Ry. on location and construction work.

Mr. T. F. Laist, recently associated with the firm of Holabird & Roche, Architects, Chicago, Ill., has been appointed Chief of the architectural department of the Central district, Division of Valuation, of the Interstate Commerce Commission, with headquarters at Chicago. Mr. Laist graduated from Cornell University in 1888, and afterward studied architecture in Europe. For five years, 1897 to 1902, he was Senior Draftsman in the office of the Supervising Architect of the U. S. Treasury Department.

Mr. C. I. Leiper, Principal Assistant Engineer of the Philadelphia, Baltimore & Washington R.R., a subsidiary of the Pennsylvania R.R., has been appointed Superintendent of the New York, Philadelphia & Norfolk R.R., also a subsidiary of the Pennsylvania R.R., with headquarters at Cape Charles, Va., succeeding Mr. R. V. Massey, promoted, as noted elsewhere. Mr. Leiper is an engineering graduate of Swarthmore College and his first railway work was as rodman with the Pennsylvania R.R. at Jersey City, N. J., in 1899.

Mr. Charles S. Churchill, Vice-President, Am. Soc. C. E., Chief Engineer of the Norfolk & Western Ry., has been appointed Assistant to the President and will have charge of the railway's valuation work. Mr. Churchill graduated from Sheffield Scientific School, Yale University, in 1879, and has been in railway location and construction work for 35 years. He has been with the Norfolk & Western Ry. since 1888, when he was made Engineer in charge of the construction of the Ohio extension. He has been Chief Engineer since 1903.

Mr. W. H. De France, recently appointed Division Superintendent of the Texas & Pacific Ry., at New Orleans, La., received his early experience in the railway engineering service. After serving as an office boy in the general passenger office of the St. Louis, Iron Mountain & Southern Ry., he was given an opportunity as a flagman in the engineering corps of the Missouri Pacific Ry. Subsequently he was promoted to be rodman and later leveler. In 1895 he was Assistant Engineer on construction for the St. Louis Southwestern Ry., which position he left to become a locomotive fireman.

Col. George W. Goethals, M. Am. Soc. C. E., Corps of Engineers, U. S. A., Chief Engineer of the Panama Canal, is to be publicly presented with the first medal awarded by the Civic Forum for "distinguished public service," at Carnegie Hall, New York City, on the evening of Mar. 4. The Hon. Joseph H. Choate will preside. President Wilson has been invited to attend and personally present the medal to Col. Goethals. Ex-Presidents Taft and Roosevelt have also been invited to attend. The National Council of the Civic Forum was unanimous in selecting Col. Goethals as the first recipient of the medal.

Mr. R. V. Massey, Superintendent of the New York, Philadelphia & Norfolk R.R., a subsidiary of the Pennsylvania R.R., at Cape Charles, Va., has been promoted to be Superintendent of the New York Terminal division of the Pennsylvania R.R., to succeed Mr. C. S. Krick, promoted, as noted elsewhere. Mr. Massey is a civil engineering graduate of Sheffield Scientific School, Yale University, and entered the service of the Pennsylvania R.R. as a rodman in 1892. He had been promoted in the engineering department to the office of Division Engineer of the New York division, when in 1911 he joined the operating staff.

Mr. D. C. Rounseville was recently promoted from the position of Resident Engineer of the St. Louis, Peoria & Northwestern Ry. (a subsidiary of the Chicago & Northwestern Ry.), at Pekin, Ill., to that of Engineer of Maintenance-of-way of the Chicago & Northwestern Ry. lines east of the Missouri River, with headquarters at Chicago, Ill. Mr. Rounseville's engineering experience began in 1879 as a chainman on the location surveys of the Milwaukee, Lake Shore & Western R.R. All his subsequent experience has been in railway work as a Locating, Construction and Division Engineer with railways which have become parts of the Chicago & Northwestern Ry. system.

Mr. James Owen, M. Am. Soc. C. E., has resigned his position as Engineer of Essex County, N. J. Mr. Owen was first appointed County Engineer in 1868 and has served continuously, with the exception of one year, until the present time, which makes 45 years' service as engineer in a public office—a most remarkable record. In England long terms of service by municipal engineers are not so uncommon. Probably two of the longest records of service in this country, besides that of Mr. Owen, are those of the late Thos. Murray, who was City Engineer of Davenport, Iowa, for about 42 years, and of Horace Loomis, M. Am. Soc. C. E., who recently retired from the New York City municipal service after 37 years of continuous duty.

Mr. William G. Atwood, M. Am. Soc. C. E., recently Chief Engineer of the Lake Erie & Western R.R., Indianapolis, Ind., has been appointed Assistant District Engineer of the Chattanooga, Tenn., district of the Valuation Division of the Interstate Commerce Commission. Mr. Atwood is a native of New York State and a graduate in civil engineering of Cornell University, class of 1892. After five years in municipal work in Chicago, Ill., and as many more as Mining Engineer and United States Deputy Surveyor in Alaska, he began railway work as Locating Engineer and Superintendent of Construction of the Alaska Central Ry. In 1907 and 1908 he was Division Engineer of the Lake Shore & Michigan Southern Ry., and subsequently Chief Engineer of the Lake Erie & Western R.R.

Mr. Harry O. Cole, M. Am. Soc. C. E., has resigned as Resident Engineer of the Fifth division of the Panama Canal, and has returned with his family to the United States. Mr. Cole has been connected with the Panama Canal work since Sept. 18, 1908, when he was appointed Assistant Engineer in the office of the Division Engineer of the old Pacific division. For a year he was in charge of all office engineering and the designing of plant and equipment for that division. In September, 1909, he was placed in charge of the Third (municipal engineering) district of the Pacific division, which position he continued to hold until his appointment as Resident Engineer in charge of the Pacific locks and dams and the dry excavation for the canal south of Pedro Miguel. When the Pacific division was abolished in 1912, Mr. Cole was placed in charge of the newly created Fifth division at Corozal. Mr. Cole is a graduate of West Virginia University, class of 1898, and until 1903 was a structural draftsman with the Keystone Bridge Co., the National Steel Co., the Structural Steel Co. and the American Bridge Co. From 1903 to 1907 he was an Assistant Engineer in the office of Virgil G. Bogue, M. Am. Soc. C. E., Consulting Engineer, New York City. In 1907 he was appointed Bridge Engineer of the Oaxaca & Pacific Ry. in Mexico. Later he served as in connection with the investigation of the Blackwell's Island Bridge, New York City.

Mr. Henry Worth Thornton, General Superintendent of the Long Island R.R., Jamaica, L. I., N. Y., has been appointed General Manager of the Great Eastern Ry., the largest railway system in Great Britain, comprising 1217 miles of track, over 1000 locomotives, 5400 passenger cars, 27,000 freight cars and 17 steamboats. The railway company also operates street omnibuses, both horse drawn and motor. In 1912 the company's property included nearly 1800 horses. In announcing the appointment of Mr. Thornton at the annual meeting of the Great Eastern Ry. Co., the Chairman, Lord Claud Hamilton remarked that he was obliged to go to the United States for a General Manager due to a great dearth in the British Isles of proficient men for railway executive positions. The man who has been thus signally honored is an American civil engineer, born at Logansport, Ind., Nov. 6, 1871, and graduated from the University of Pennsylvania in 1894. Mr. Thornton entered into engineering work in 1894 as a draftsman with the Pennsylvania R.R. Lines West of Pittsburgh. Subsequently he was promoted to be Assistant Engineer on construction of the Cleveland & Marietta R.R.; Topographer attached to the Chief Engineer's office of the Southwest System, Pennsylvania R.R.; Supervisor at Columbus, Ohio; Assistant Engineer of the Cincinnati division, and Assistant Engineer on special work. In November, 1899, he received an appointment as Engineer of Maintenance-of-way of the Erie & Ashtabula division of the Northwest System of the Pennsylvania lines. In March, 1901, he left the engineering for the operating department, becoming Superintendent of the Marietta division. He was subsequently promoted to the superintendency of more important divisions, and in February, 1911, became Assistant General Superintendent of the Long Island R.R., a subsidiary of the Pennsylvania R.R. The following November he was promoted to be General Superintendent. Mr. Thornton is married and has two children. The appointment has aroused extraordinary interest in England and has been the subject of lengthy editorial comment in London newspapers.

OBITUARY

Frank Paul Barber, a civil engineer, of New Orleans, La., died in that city, Feb. 10, aged 45 years.

Franklin Phillips, M. Am. Soc. M. E., President of Hewes & Phillips Iron Works, Newark, N. J., died Feb. 10, from pneumonia. He was widely known as a mechanical engineer and had been a member of the American Society since 1881.

D. W. Grant, widely known throughout the Northwest as a railway construction contractor, died recently at his home in Faribault, Minn. In partnership with his brother, Donald Grant, he constructed many miles of railway grade in the Northwest.

Truxton Craven, only son of Alfred Craven, M. Am. Soc. C. E., Chief Engineer of the Public Service Commission, First District, New York State, died Feb. 9, as a result of injuries received in an automobile accident early in the same day. Young Mr. Craven was Superintendent of the estate of Mr. Harry Payne Whitney, at Manhasset, Long Island.

W. J. Gilmartin, formerly Superintendent of the Buffalo & Susquehanna R.R., at DuBois, Penn., lately Superintendent of the Chihuahua division of the Mexican Northwestern R.R., was among those who perished in the Cumbre Tunnel fire on Feb. 4. He resided at Driftwood, Penn., in his boyhood, and later at Sterling Run. He has two brothers on the Philadelphia & Erie division of the Pennsylvania R.R., John and William, both of whom have gone to Mexico to recover the body of their brother, if possible. Mr. Gilmartin made rapid strides in his profession and had a host of friends, who are grieved to learn of his untimely end. [From H. M. Fry, Erie, Penn.]

William Henry Boardman, for many years President of the "Railroad Gazette," now the "Railway Age Gazette," died at his home in Ridgefield, Conn., Feb. 16. He was born in Dixon, Ill., in 1846. His father was a newspaper publisher and owned the Dixon "Telegraph." Here Mr. Boardman first learned the rudiments of the publishing business. In 1869 he graduated from the University of Michigan, having served during his summer vacations as a member of survey parties on the Lake Survey of the U. S. Engineer Department. After his college course he was employed by the "Railroad Gazette," then published in Chicago. The plant of the publishing company was destroyed in the great fire of 1871, and Mr. Boardman is said to have brought all the remaining assets in a bag to New York City, where the publication of the paper was soon resumed. Until 1911 he gave all his time to the work of publishing this paper and for eight years was its editor. Mr. Boardman was married in 1874 to Miss Henrietta F. Hall, of Rutland, Vt., who, with three sons and two daughters, survives him.

Walter Ambrose Pearson, M. Am. Inst. E. E., for several years associated with his brother, Dr. F. S. Pearson, M. Am. Inst. E. E., of New York and London, died in New York City, Jan. 25. W. A. Pearson was born in Putnam, Conn., in July, 1869. He graduated from Tufts College in 1890. Following his graduation he entered the employ of the West End Street Ry., Boston, Mass. Three years later he went to Brooklyn, N. Y., where he was Electrical Engineer in charge of the electrification of the Brooklyn Heights R.R. In 1896 he was appointed Electrical Engineer of the Metropolitan Street Ry., New York City, where he remained until 1906. For some time following he was engaged on the electrical installation and construction of the power plant of the Electric Development Co. of Ontario, at Niagara Falls, Ont. From 1910 to 1912 he was Assistant General Manager of the Rio de Janeiro Tramway, Light & Power Co., Rio de Janeiro, Brazil. Returning to this country, he became associated with Bertron, Griscom & Co., Bankers, New York City, as Consulting Engineer. Mr. Pearson was a member of the American Society of Mechanical Engineers, the New York Railroad Club and the Engineers Club, New York.

Ricardo M. Arango, M. Am. Soc. C. E., Consulting Engineer for the Republic of Panama, whose death at his home in the City of Panama on Jan. 24 was briefly noted in our obituary columns of Feb. 5, was born Dec. 25, 1864, and was graduated with the degree of Civil Engineer from the Rensselaer Polytechnic Institute, in 1887. His first work after graduation was to make a survey under the direction of Mr. Pedro J. Sosa, a prominent Panamanian Engineer, of 500,000 hectares of land in the Providence of Bocas del Toro, ceded by the Columbian Government to the French Canal Co. This party did the first surveying work in that region. In 1889, he was appointed by the Colombian Government to take charge of surveys made necessary by the controversy between it and the Panama R.R., over the filling of the present site of Colon. In 1890, he worked on the railroad which was built to haul to the coast the products of the manganese mines of Viento Frio, Province of Colon. He helped to make the surveys and plans for providing the City of Panama with water from the Juan Diaz River. This development never was realized.

Mr. Arango took an active part in the Revolution of 1903, by which Panama secured its independence from Colombia, being of great assistance to his father, José A. Arango, who was a member of the original Junta of Separation. As member of the Municipal Council of the City of Panama, he signed the Act of Independence. He was the first Chief Engineer of the new Republic.

Under Chief Engineer John F. Wallace, of the Isthmian Canal Commission, Mr. Arango was Consulting Engineer for sanitary work in the City of Panama. Later he was made Division Engineer of the Bureau of Meteorology and River Hydraulics. As head of this bureau, he installed the first seismograph on the Isthmus and established the gaging station at Alhajuela, on the Chagres River, from which warning of floods could be telephoned, in advance, to those in charge of work on the lower reaches of the river.

His services with the Isthmian Canal Commission were terminated in the fall of 1908. Soon after this he was appointed Minister Plenipotentiary and Envoy Extraordinary, for the Republic of Panama, to the Court of St. James, a post that he had to relinquish in 1909 on account of ill-health. In 1910, he was again made Chief Engineer of the Republic, and later, Consulting Engineer, which position he held at the time of his death. He was a member of the Instituto de Ingenieros de Chile, the Seismological Society of America and of the Sociedad de Ingenieros, Arquitectos y Agrimensores de Panama, of which he was the founder. He was married to Miss Maria Lewis, Sept. 21, 1899, who, with five children, survives him. [Contributed by Alex P. Crary, Assoc. M. Am. Soc. C. E., Ingeniero de Puentes y Estructuras, Metalicas, Republic of Panama.]

ENGINEERING SOCIETIES

COMING MEETINGS

MINNESOTA ENGINEERS' AND SURVEYORS' SOCIETY.
Feb. 24-25. Annual meeting at St. Paul, Minn. President, Wm. Danforth, 411 Hackney Building, St. Paul.

INDIANA SANITARY AND WATER SUPPLY ASSOCIATION.
Feb. 26-27. Annual meeting at Indianapolis, Ind. Secy., Dr. W. F. King, Indianapolis.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Mar. 2-7. Annual meeting at New Orleans, La. Secy., Theo. A. Randall, Indianapolis, Ind.

VERMONT SOCIETY OF ENGINEERS.
Mar. 12. Annual meeting at Burlington, Vt. Secy., Geo. A. Reed, Barre, Vt.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 17-20. Annual convention at Chicago, Ill. Secy., E. H. Fritch, 900 S. Michigan Ave., Chicago.

HIGHWAY ENGINEERS' ASSOCIATION OF MISSOURI.
Mar. 18-20. Annual meeting at St. Joseph. Secy., Ray L. Gargill, St. Joseph, Mo.

IOWA STREET AND INTERURBAN RAILWAY ASSOCIATION.
Apr. 22-25. Annual meeting at Waterloo, Iowa. Secy., H. E. Weeks, Tri-City Ry. & Light Cos., Davenport, Iowa.

ILLINOIS WATER-SUPPLY ASSOCIATION.
Mar. 9-11. Annual meeting at the University of Illinois. Secy., Edward Bartow, Urbana, Ill.

American Road Builders' Association—At the annual meeting for the election of officers, held at the Hotel Astor, New York City, on Feb. 6, the following were elected: President, W. A. McLean (Commissioner, Department of Public Works, Toronto, Ont.); First Vice-President, Geo. W. Tillson (Consulting Engineer, Brooklyn, N. Y.); Second Vice-President, A. W. Dean (Chief Engineer, Massachusetts Highway Commission, Boston, Mass.); Third Vice-President, A. B. Fletcher (Highway Engineer, California Highway Commission, Sacramento, Calif.); Treasurer, W. W. Crosby (Consulting Engineer, Baltimore, Md.); Secretary, E. L. Powers (Editor "Good Roads," 150 Nassau St., New York City).

American Society for Fire Prevention—The organization meeting was held on Feb. 11 at the Society offices at 51 Chambers St., New York City. Abram W. Herbst was chosen Director of Safety of the Society. He will have charge of all the technical work of the Society, being guided by an Advisory Board which includes the following: E. A. Weimer, Reginald Pelham Bolton, Charles Gould Armstrong, Henry Snyder Kissam, James P. Whiskeman, Frederic C. Mott and Frederick A. Forgee. Chas. W. Abrams was elected Treasurer and Bernard Glaser, Secretary. A statement was issued concerning the work of the Society. According to it, 90% of all fires are unnecessary, and it is the purpose of the Society to reduce this percentage.

National Brick Manufacturers' Association—The 28th annual convention will be held in New Orleans, La., Mar. 2-7. The Board of Directors of the National Paving Brick Manufacturers Association will hold a meeting in New Orleans on Mar. 2 and 3. The National Clay Machinery Manufacturers Association will also meet there during that week. A program of entertainment is being prepared by the local committee and will include among other features, the usual annual banquet, the informal reception and smoker, and an inspection trip to the plant of the Salmen Brick & Lumber Co., at Slidell, La. The secretary of the Association is Theo. A. Randall, Indianapolis, Ind.

The American Institute of Mining Engineers—At the annual meeting held in New York City, Feb. 16-19, the following papers were presented: "Heat Treatment of Steel Castings," by C. D. Young, O. D. A. Pease and C. H. Strand; "American Steel Rail Situation," by R. W. Hunt; "Manganese-Steel Rails," by Sir Robert Hadfield; "The Use of Petroleum in Dust Prevention and Road Preservation," by W. W. Page; "The Burning of Coal Beds in Place," by Alexander Bowie; "Water Intrusion and Methods of Prevention in California Oil Fields," by Franklyn W. Oatman; "The Age and Manner of Formation of Petroleum Deposits," by E. T. Dumble. The following officers were elected: President, Benjamin B. Thayer: Vice-Presidents, H. C. Hoover and W. L. Saunders; Secretary, Bradley Stoughton, 29 W. 39th St., New York City.

St. Louis Association of Members of the Am. Soc. C. E.—The principal business of the Feb. 11 meeting was a discussion of the proposed amendments to the constitution of the American Society of Civil Engineers. Motions were adopted declaring the feeling of the attending members to be as follows: No on Amendment A; Yes on Amendments B and C. The secretary was instructed to notify all members of the Association of the action of the meeting and to request them to cast their ballots accordingly. The following officers were elected: President, J. A. Ockerson; Vice-President, E. E. Wall; Secretary, G. G. Black.

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